SAN FRANCISCO CLEAN WATER PROGRAM

Sunnydale Facilities Project Report Amendment to the Bayside Facilities Plan

DECEMBER 1986

SUBMITTED BY

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
CLEAN WATER PROGRAM

SUNNYDALE FACILITIES PROJECT REPORT

AMENDMENT TO THE BAYSHORE FACILITIES PLAN

DECEMBER, 1986

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1. INTRODUCTION

SUNNYDALE PROJECT AMENDMENT REPORT

INTRODUCTION

The Sunnydale-Yosemite and Hunters Point planning effort, an element of the Bayside Facilities Plan, was suspended in 1981, prior to the completion of the EIR, as a result of Federal funding cutbacks. When Combined Sewer Overflow (CSO) monies became available, the work was divided into three segments to address reduced funding levels. At this point the Yosemite and the Hunters Point projects have been completed but the Sunnydale Environmental Review has not been done.

Since 1981, substantial changes have occurred in both land use constraints and proposed design of interrelated facilities. Because these changes could result in substantial cost savings in both construction and site acquisition, an additional planning effort was warranted for the Sunnydale Facilities.

In addition, the design of various elements of the Bayside Facilities has made it apparent that moving the Sunnydale Facilities up in priority will result in a greater environmental benefit to the total Sunnydale-Yosemite area at an earlier date for approximately the same expenditure level. This was described in detail in the City's letter to the State dated September 25, 1984, which is attached as Annex II to this study.

This amendment to the "Bayside Facilities Plan - Southeast Bayside Project Report, March 1982" re-examines the Sunnydale Facilities only. In Section 4 of this report, a development of initial alternatives is conducted on the basis of the availability of additional downstream sites. Section 4 also screens the seventeen initial alternatives down to five final alternatives. Section 5 provides an analysis of the final five alternatives. Section 6 gives a summary of the comparison of alternatives leading to the selection of the apparent best alternative (ABA). Finally, Section 7 describes the details of the ABA.

Various alternatives for reducing wet weather overflows to an average of one per year in the Sunnydale area were described in the "Bayside Facilities Plan, Southeast Bayside Project Report, March, 1982". The Sunnydale and the Yosemite-Fitch drainage areas were studied as a unit and the Apparent Best Alternative (ABA) concluded that the facilities of the two tributary areas should be hydraulically independent. Flows from the two areas would be transported in a structure which would have two compartments to separate the flows and would be pumped by a structure which had separate pumping bays. The main advantage of this hydraulic separation of the two areas is that the Sunnydale System would depend on gravity as the means to transport flows to Yosemite.

A refinement of calculations by using a detailed model analysis indicated that the overall requirements for storage could be reduced by making the Sunnydale system pump-dependent instead of gravity-dependent.(1) Making Sunnydale pump-dependent eliminates the need for separate compartments in the Yosemite-Fitch Transport-Storage facilities. The hydraulic and hydrologic characteristics of the two tributary areas indicated that these facilities were more effectively utilized when acting as a single unit rather than with separate compartments; i.e., the entire capacity of the Griffith Pumping Station could be applied earlier in a storm and the volume occupied by the second compartment could be used as storage at no extra cost. Furthermore, a more detailed evaluation of the existing runoff coefficient ("C" Factor) in the Sunnydale area indicated that the storage requirement for present day development is less than that required for ultimate development.(2) The above calculations led to re-investigation of the alternatives for handling the flows from the Sunnydale area.

(1) See Annex I, Appendix A

(2) See Annex I, Appendix B

SUMMARY

An apparent best alternative project for the Sunnydale area was described in Chapter 5 of the "Bayside Facilities Plan, Southeast Bayside Project Report, March 1982'. Since the 1982 report was completed, refinements in hydraulics and hydrologic calculations have resulted in major changes to the proposed facilities. Also, changes in regulatory agency attitudes concerning compatible use of areas under their jurisdiction allowed consideration of alternative sites. These changes have been considered with the result that an amendment to the project report for the Sunnydale transport-storage facility is required. This Amendment Report with its annexes should be used as the basis for further implementation of the Sunnydale facilities only. All of the proposed Sunnydale facilities will be needed to control combined sewer overflow and only a minor modification may be required for further Master Plan implementation. An increase in pump station capacity may be required in the future in the event that development in the Sunnydale drainage district increases the runoff coefficient from C=0.48 to C-0.52.

In this amendment report, seventeen alternatives were studied. One of the alternatives was the no project alternative. Five of the alternatives were gravity-dependent, five alternatives were pump-dependent with storage

reservoirs and six of the alternatives were pump-dependent with transport-storage structures. Screening of the alternatives led to the elimination of twelve options primarily as a result of impacts during construction, operational problems, or failure to meet governmental requirements. The five final alternatives selected for evaluation were 2-1, 2-2B1, 2-8, 2-3A and 2-10. Final alternative 2-1 is a gravity-dependent solution. Alternative 2-2B1 is a pump-dependent solution with a reservoir. Alternatives 2-3A, 2-8 and 2-10 are pump dependent solutions with a transport storage structure. The evaluation procedure used to compare the final alternatives consists of ranking each alternative against the set of evaluation factors developed in the 1982 Bayside Facilities Plan. These factors include cost, energy consumption, land requirements, traffic impacts, flexibility, reliability, implementability, and public acceptability. The importance of each factor was considered, and a comparison was made of a series of trade-offs between the advantages and disadvantages of each alternative against other alternatives. Comparison of the five remaining alternatives led to the selection of Alternative 2-10 as the new Apparent Best Alternative.

The five final alternatives were sized to store and transport combined sewer storm flows out of the Sunnydale basin such that no more than one overflow per year occurs on the long-term average in the Sunnydale basin. In addition, the facilities were sized to convey the five year storm flow rate into the Bay through the outfall structures. Facilities were arranged so that all overflows to the Bay occur from a baffled storage structure.

The selected apparent best alternative, 2-10 consists of a control structure at the existing Sunnydale combined sewer overflow point, a 60-inch diameter pipe from the control structure to the existing Candlestick Tunnel, 5.7 million gallon transport storage structure along the shoreline, a 50 mgd pumping station, a 48-inch diameter force main, and a control structure with a gate. The apparent best alternative is described in detail in Chapter 7 of this report.

3. BACKGROUND

BACKGROUND

In 1981, Federal funding cutbacks resulted in the suspension of environmental review efforts for the Sunnydale Facilities. When the effort was suspended, an Apparent Best Alternative (ABA) had been chosen. The choice of the ABA was based, to a great extent, on alternatives limited by the land use criteria of some of the governing agencies. As a result, a few potential sites were not explored or were addressed only briefly. The two plus years that have elapsed since the planning was suspended have shown a marked change in agency attitudes concerning compatible use. The 1981 ABA utilized a privately owned manufacturer's storage site. As such, acquisition and relocation costs could be quite high. A number of sites currently to be considered for investigation are on publicly owned land that is undeveloped.

During the prior facilities planning work, the Sunnydale and Yosemite/Fitch projects were treated as one project because of the degree of interaction between the two systems. However, in order to address the funding cutbacks, these two projects were separated. The environmental review of the Sunnydale area was not completed. The Yosemite/Fitch EIR and design of the facilities have been completed. By virtue of the refining process that occurred to the Yosemite Plans during design and value engineering, it became apparent that compatible changes in the Sunnydale facilities could result in sizeable construction dollar savings on both projects.

The refining process which occurred during design of the Yosemite/Fitch facilities and reevaluation of the Sunnydale facilities included an analysis of the operation of the Sunnydale lift station, a comparison of a gravity-dependent system versus a pump-dependent system, and a detailed analysis of the present and potential ultimate values for the runoff coefficient ("C" Factor) of the Sunnydale watershed. The results of these investigations are included in a report entitled

"A Summary Report of Planning and Design for Yosemite Fitch and Sunnydale Drainage Basin - CSO Facilities, June, 1985" which is attached as Annex I to this Amendment Report.

4. DEVELOPMENT AND SCREENING OF INITIAL ALTERNATIVES

DEVELOPMENT AND SCREENING OF INITIAL ALTERNATIVES

General

The development of alternatives for this amendment was based on reevaluating potential sites in the Sunnydale area which were made available as a result of changes in governmental constraints and planned development. These alternatives were developed initially by simply relocating the facilities which were defined in the 1982 Project Report.

As a part of this investigation, the advantages of a pump-dependent system in Sunnydale versus a gravity-dependent system, were studied. This study concluded that by placing facilities in the downstream portions of the drainage basin, such that all flows could be intercepted or easily routed into storage, a pump-dependent system would reduce the volume of required storage in both the Sunnydale and Yosemite/Fitch facilities.

Furthermore, a more detailed analysis of the present runoff coefficient of the Sunnydale watershed was completed. The result of this analysis also provided reason for some changes to the required facilities.

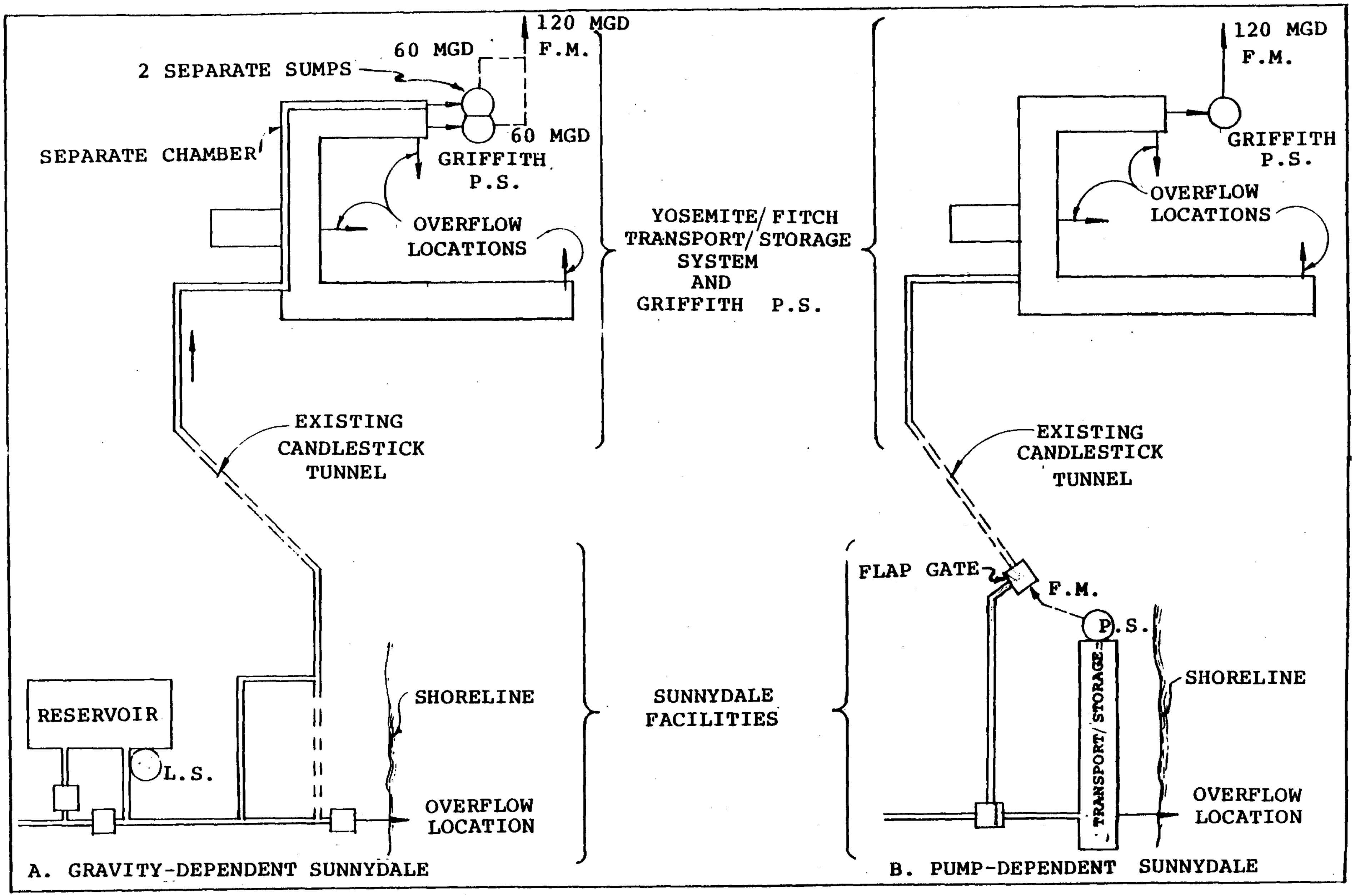
These studies are included as Annex I to this study. A summary of the results of these reports is given below.

Required Facilities

Gravity vs Pumping Scenarios

The detailed description of the gravity versus pumping scenarios for conveying flows from the Sunnydale to the Yosemite Basin is given in Appendix A of Annex I. A schematic representation of these two scenarios is shown in Figure 4-1. In summary, the important features of the two scenarios are as follows:

FIG. 4-1 SUNNYDALE AND YOSEMITE FACILITIES. SCHEMATIC REPRESENTATION OF TWO BASIC SCENARIOS



□ - CONTROL STRUCTURES

F.M. - FORCE MAIN

○ - P.S. PUMP STATION

L.S. LIFT STATION

- Gravity-Dependent System (underlined in original)

    - Sunnydale flows are transported by gravity through the existing Candlestick Tunnel to the Yosemite-Fitch (Y-F) facilities. Only a lift station is required to dewater the Sunnydale Reservoir. The original ABA calculated that a 10 million gallon (mg) reservoir was required in the Sunnydale area. However, the 10 mg capacity was calculated on the basis that the lift station would not go into operation until the reservoir had drained by gravity to a level below the existing sewer system. By putting the lift station into operation for the maximum periods in which downstream capacity was availalbe, it was determined that storage volume in Sunnydale could be reduced to 7.5 mg. See Table 4-1.
    - Sunnydale flows are transported in a separate chamber in the Y-F facilities to a separate sump in the Griffith Pump Station. The separate sump operates independently to discharge flows. The separation is required to prevent raising the hydraulic controls in the Sunnydale area by the flow levels in Y-F.

- Pump-Dependent Sunnydale System
    - Sunnydale flows go into storage after the 60 mgd capacity of the Candlestick Tunnel is reached. Sunnydale flows will also be diverted into storage for pumping when flows in Yosemite reach a level of -18 ft. This is the level in the Yosemite system which would cause flooding in the Sunnydale area under gravity conditions. A control structure upstream of the force main discharge point forces all Sunnydale flows to go into the storage facility before being pumped to the Y-F facility.

Table 4-1 Sunnydale-Yosemite Storage Facilities Comparison of Concepts by Storage Volume

	SUNNYDALE STORAGE (MG)	YOSEMITE STORAGE REQUIRED (MG)	TOTAL YOSEMITE/ FITCH AND SUNNYDALE STORAGE REQUIRED (MG)	EXISTING SYSTEM STORAGE AVAILABLE IN YOSEMITE AREA (MG)	TOTAL NET STORAGE TO BE CONSTRUCTED (MG)	Remarks
1. Gravity-Dependent Sunnydale (C=0.6)						
a. CGKT	10	14.7*	24.7	1	23.7	*including 0.7 MG occupied by 2nd chamber
b. CWP	7.5	16.7*	24.2	1	23.2	ditto
2. Pump-Dependent Sunnydale (C=0.6)						
	7.5	14.1	21.6	2**	19.6	Original estimate of runoff coefficient C=0.6
3. Pump-Dependent Sunnydale (C=.48)						
	5.7	11.5	17.2	2**	15.2	Current development conditions Sunnydale
4. Pump-Dependent Sunnydale (C=.52)						
	5.7	12.7	18.4	2**	16.4	Ultimate Sunnydale development
5. Gravity-Dependent Sunnydale (C=.52)						
	5.7	16.7*	22.4	1	21.4	*including 0.7 MG occupied by 2nd chamber

CGKT: Caldwell-Gonzalez-Kennedy-Tudor Consulting Engineers March 1982 Report Figures
CWP: Clean Water Program Figures From This Report
** Includes 1 million gallons in Candlestick Tunnel.

- The requirement for a second chamber is removed from the Y-F facility and the Griffith Pumping Station can act as a single pump station. The entire 120 mgd capacity can be applied to the combined Y-F and Sunnydale flows.

The result of this investigation, as shown on Table 4-1, is that a pump-dependent Sunnydale System will reduce the total storage required from 24.2 to 21.6 million gallons. It also showed that Yosemite-Fitch will benefit from an additional one million gallons of storage in the Candlestick Tunnel. The total net storage to be constructed is thus reduced by 3.6 mg, from 23.2 mg to 19.6 mg.

Present vs Ultimate Development

The original hydrological studies associated with the sizing of the Sunnydale facilities were based on the assumption of full development in the watershed.

The runoff coefficient for full development had been estimated to be 0.6. Inasmuch as Sunnydale is not fully developed and since the watershed has a relatively large park area, a decision was made to conduct a detailed analysis of the present vs the potential ultimate runoff coefficient. The results of this analysis are reported in detail in Appendix B of Annex I.

In summary, the analysis showed that the present "C" factor is 0.48, while the potential future value is 0.52. This resulted in decisions to change the facilities in Yosemite-Fitch area as well as in the Sunnydale area. Table 4-1 shows the storage required for "C" values of 0.48 and 0.52. The curves, which were developed to show the relationship between storage volume and pumping capacity for different "C" values, are shown in Figure 4-2. The curve shows that the required total Sunnydale and Yosemite storage volume is 17.2 mg for C=0.48.

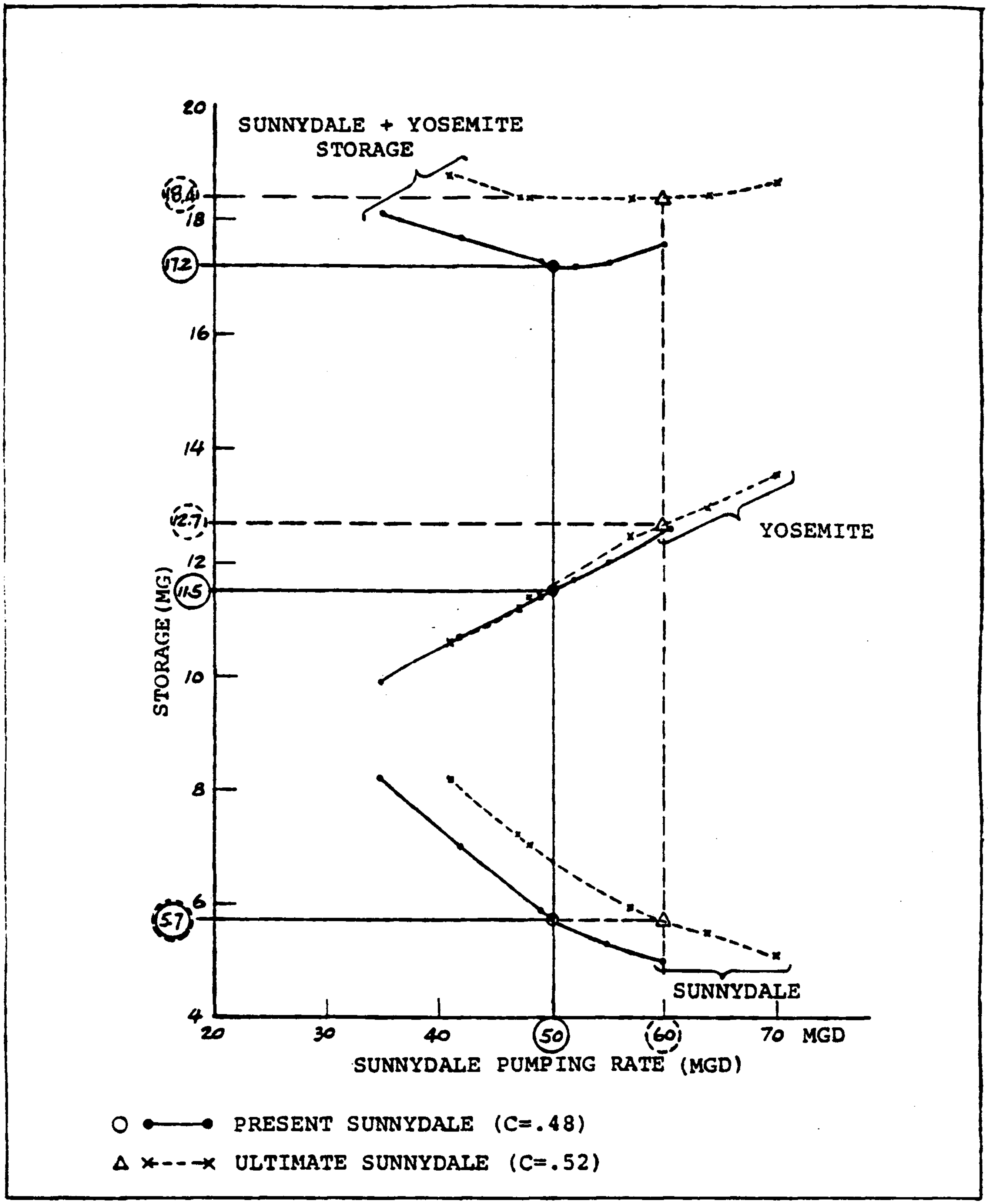


FIGURE 4-2 SUNNYDALE AND YOSEMITE TRADE-OFF CURES. STORAGE NEEDS UNDER PRESENT AND ULTIMATE DEVELOPMENT CONDITIONS

The corresponding storage volume in Sunnydale for this minimum total volume is 5.7 mg with a Sunnydale pumping rate of 50 mgd. Development of the Sunnydale watershed to a C=0.52 would require a total volume of 18.4 mg which would require the addition of 1.2 mg of storage in the Yosemite area and an increase in the Sunnydale pumping rate to 60 mgd.

The additional 1.2 mg of storage required in the Yosemite area (from 11.5 to 12.7 mg, see Table 4-1 or Figure 4-2) could be combined with the construction of the Shafter Outfall. The increase in Sunnydale pumping rate can be accomplished by replacement of the 50 mgd pumps with 60 mgd pumps. The decision tree used in arriving at these conclusions is shown in Figure 4-3.

Siting Considerations

The sites used for evaluation of alternatives in the original Bayside Report were selected after considerations of size, geologic condition, and governmental constraints. For this analysis, the pump-dependent scenario added another constraint. The site had to be far enough downstream so that the storage/pumping facility could intercept all tributary flows.

The original sites investigated for the Sunnydale Facilities are shown on Figure 4-4 as Site 1 through 7. Sites S-8, S-9, S-10 and S-11 have been included in this study as a result of changed constraints. Site S-8 had been deemed infeasible by the original study because of governmental agency constraints and presumed geological conditions. However, changes in the constraints imposed by these agencies and the results of additional geological studies have made this site feasible. The report for the geological study is included as Annex III of this Amendment.

Site S-11 was developed for a new tunnel alignment under the Bayview Park Hill. The cost of the tunnel alternatives studied were over twice as high as the others in the study. Therefore, the tunnel alternatives were dropped from further consideration.

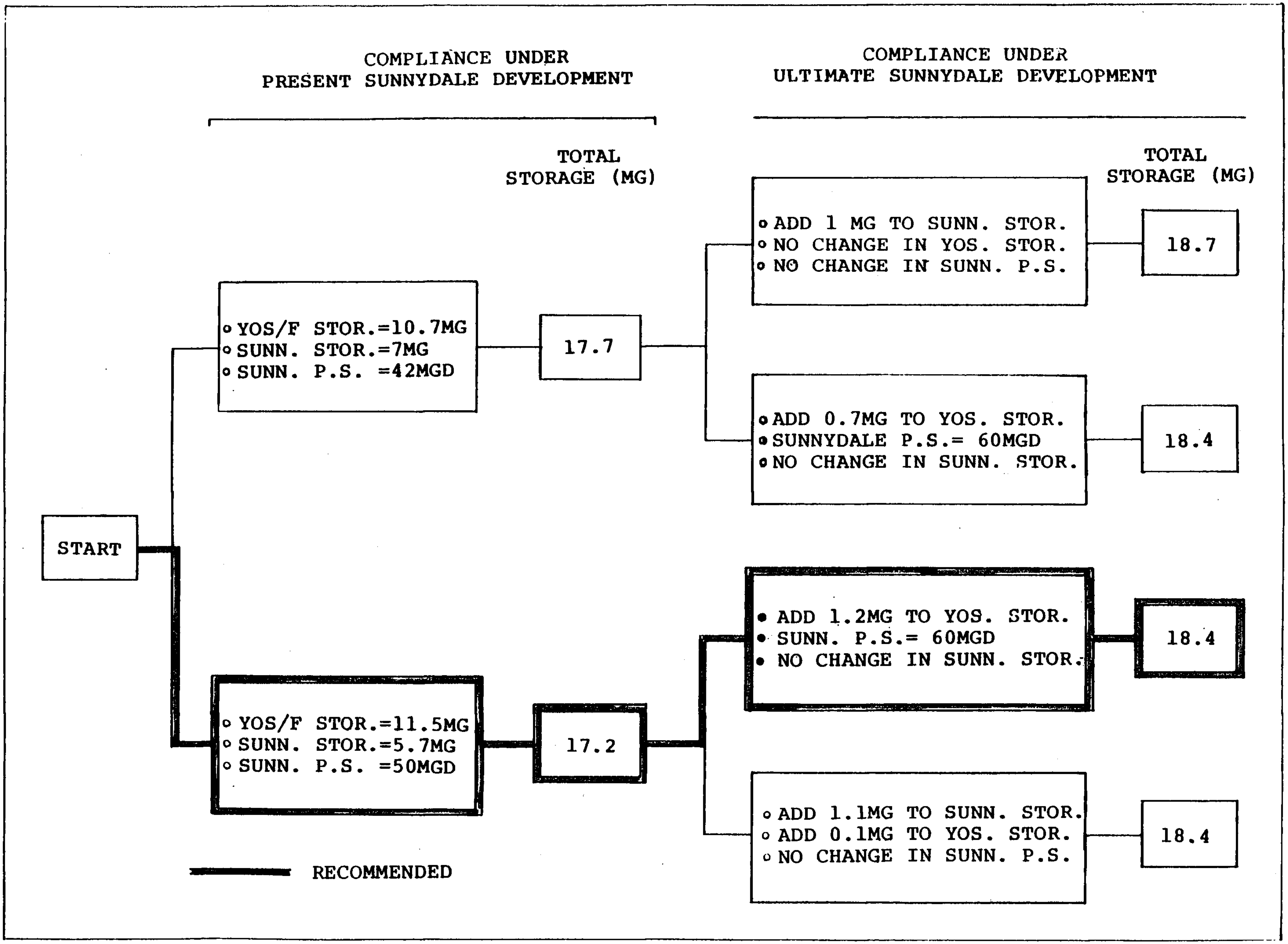
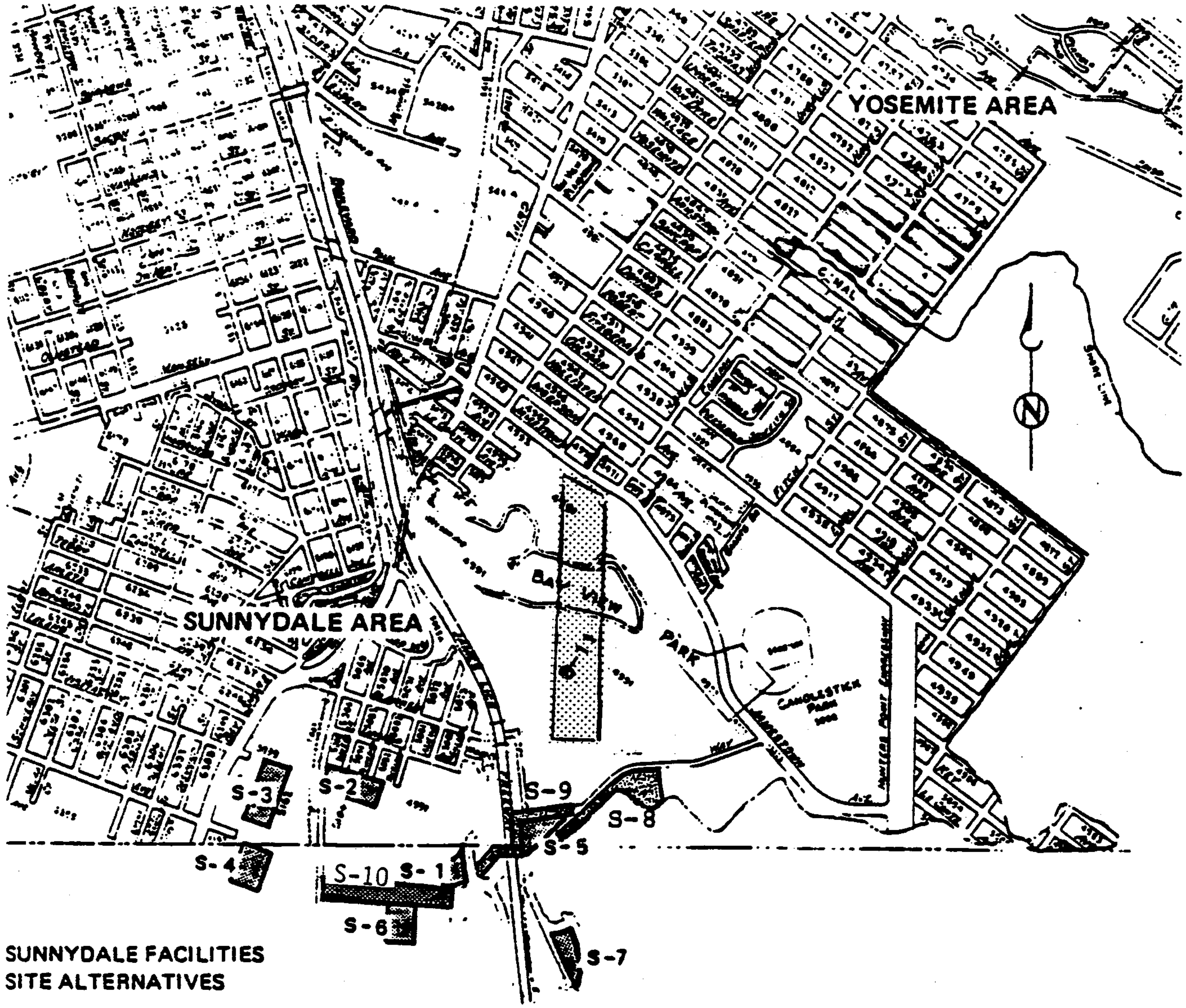


FIGURE 4-3 SUNNYDALE-YOSEMITE FACILITIES. ALTERNATIVE WAYS TO ACHIEVE COMPLIANCE UNDER PRESENT AND ULTIMATE DEVELOPMENT CONDITIONS.



SUNNYDALE FACILITIES
SITE ALTERNATIVES

S-1 SCAVENGER
S-2 WHEELER (CECO)
S-3 BAYSHORE BLVD.
S-4 SUNNYDALE
S-5 HARNEY
S-6 BEATTY
S-7 BAYSHORE FREEWAY
S-8 BAY SITE
S-9 ALANA WAY
S-10 BEATTY ROAD
S-11 TUNNEL ALIGNMENT

SCALE:

0 500' 1000' 2000' 3000'

LEGEND:

FACILITY SITE ALTERNATIVE

FIG. 4-4 SUNNYDALE FACILITIES SITES

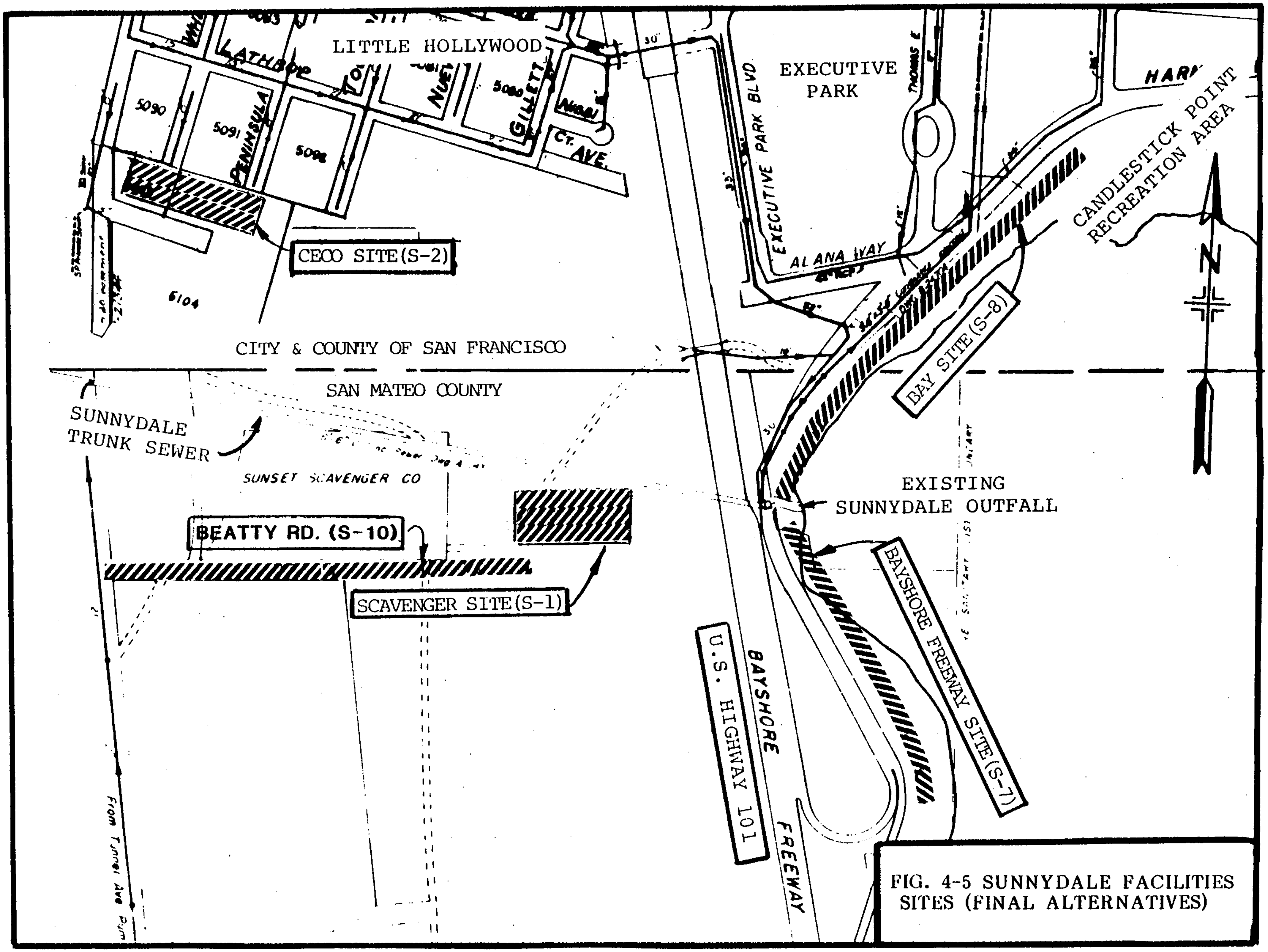


FIG. 4-5 SUNNYDALE FACILITIES SITES (FINAL ALTERNATIVES)

A screening of these nine feasible sites indicates that Sites S-1, S-7, S-8 and S-10 are acceptable for consideration because of their downstream location. Site S-2 is also considered to provide a comparison to the gravity-dependent scenario developed in the original report. Site S-5 is not included in this review because it is private property and there are current plans for the construction of a restaurant at the site. Sites S-3, S-4, and S-6 were not included because of their upstream location and/or distance from the Sunnydale trunk sewer. The five acceptable sites are shown on Figure 4-5. The CECO (S-2) site is described in the original report. The four new sites are as follows:

Site S-1: The Scavenger Site

This site is located west of U.S. Highway 101, just south of the San Francisco County line, at the Sunset/Scavenger solid waste transfer property. The site is owned by the Sunset/Scavenger Co. and the Sanitary Landfill Co. The geology of the site is poor. Several alternative locations within the property were considered. The most suitable location on the property is currently used as a parking lot and for transfer truck storage. It is under the governmental jurisdiction of San Mateo County.

Site S-7: The Bayshore Freeway Site

This site is located to the east of the freeway off/on ramp at Harney Way. The property is owned by Santa Fe Pacific Realty which has indicated that it is surplus land. The geology of the site is poor. It is under the governmental jurisdiction of San Mateo County and the City of Brisbane. Permitting agencies include: State lands, BCDC, and the Army Corps of Engineers.

Site S-8: The Bay Site

This site is located along the Bay shoreline running parallel to Harney Way from the Sunnydale overflow structure north to the main body of the Candlestick Point Recreation Area. The geology of the site is good; rock was located within 30 feet of the surface at the outfall and dense bay sands are within 24 feet of the surface at the two tested locations just offshore. It is under the governmental jurisdiction of San Mateo County. Permitting agencies include: BCDC, State Parks, State Lands, and the Army Corps of Engineers.

Site S-10

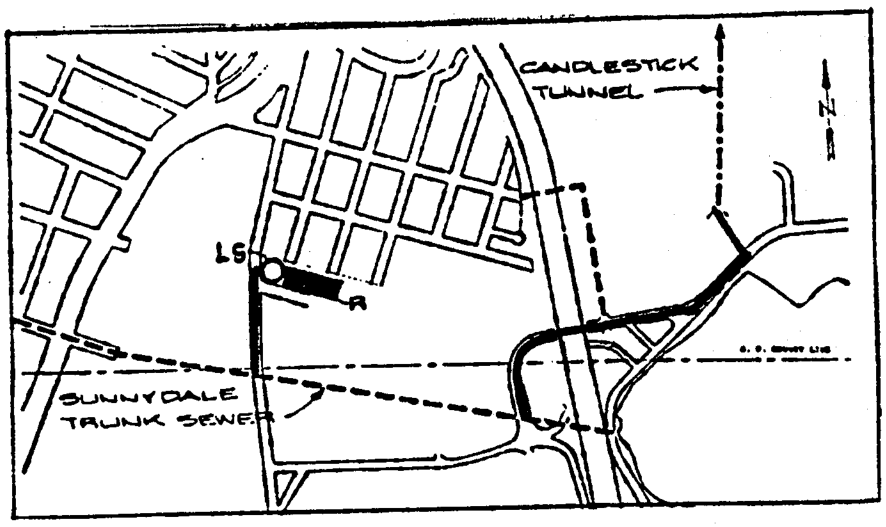
This site is located in Beatty Road, owned by City of Brisbane in San Mateo County.

Screening of Initial Alternatives

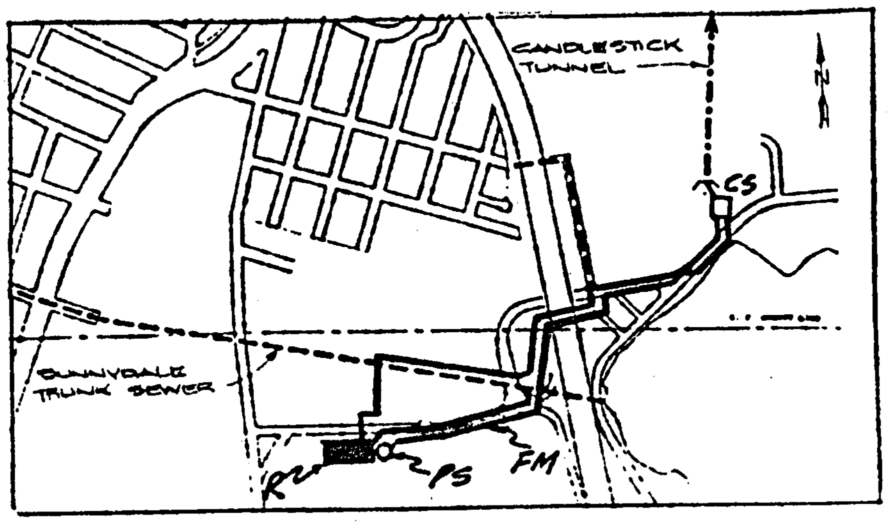
Based on the facility requirements and planning criteria, seventeen initial alternatives were developed. One alternative was the no project alternative. The remaining sixteen alternatives were generally categorized as gravity-dependent or pump-dependent systems. The pump-dependent systems are further divided into the different configurations used for the storage facility, either a reservoir, a tunnel or a transport-storage facility. These different configurations were selected depending on the site being reviewed. On some sites, the size and shape allowed both configurations to be investigated. These sixteen alternatives are shown on Figures 4-6 and 4-7.

FIG. 4-6 SUNNYDALE T/S FACILITIES

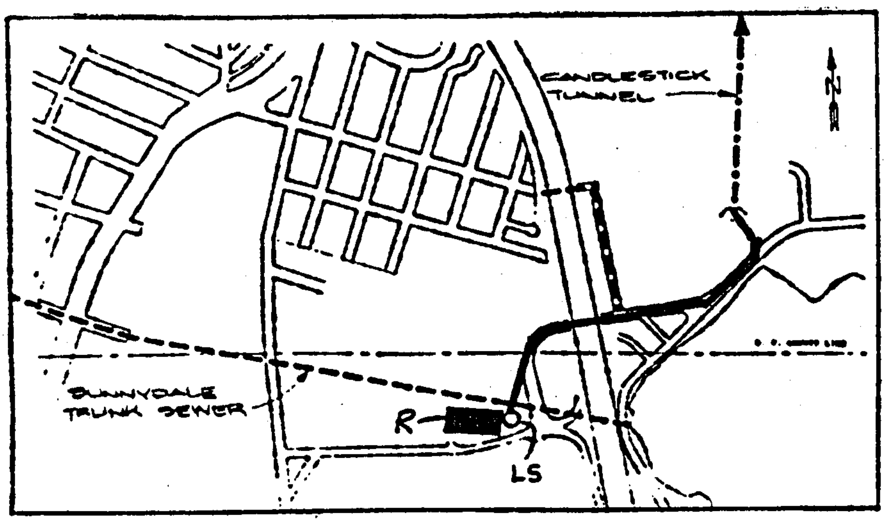
ALT. 2-1, 2-2A, 2-2B, 2-2B1, 2-2B2, 2-5, 2-6



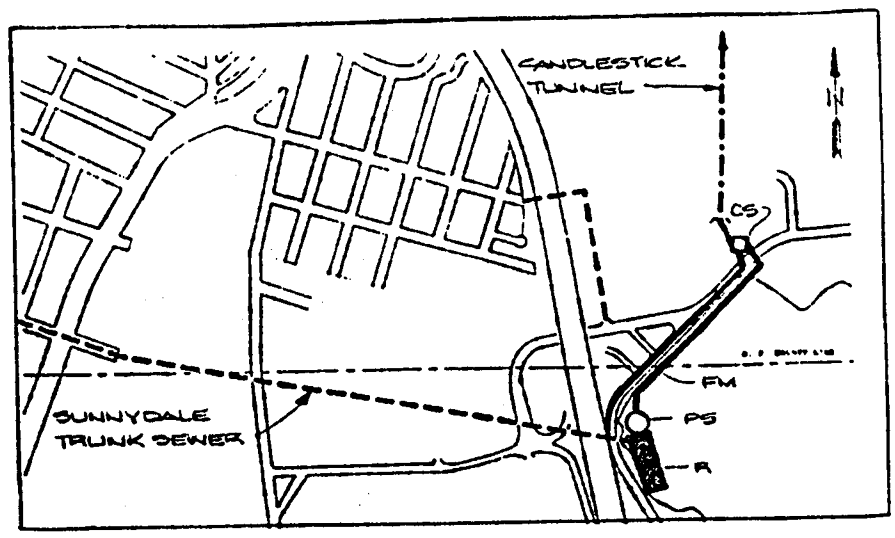
ALT. 2-1 (CECO SITE)
GRAVITY ALTERNATIVE



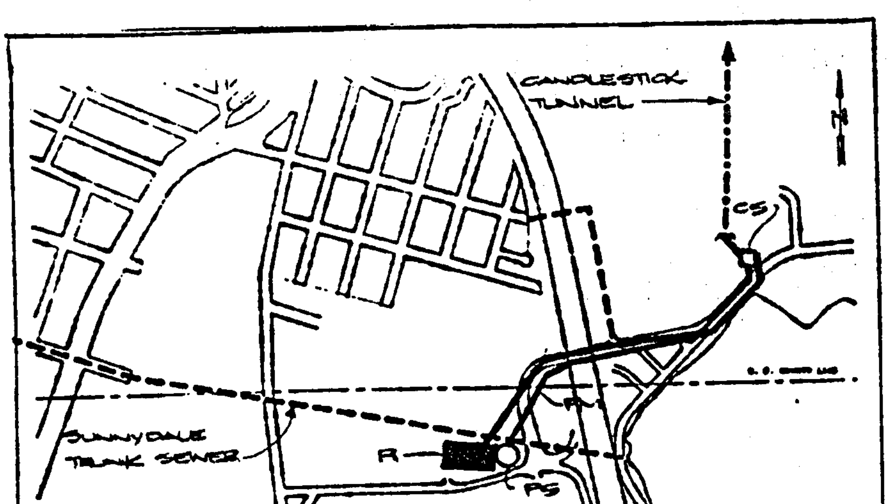
ALT. 2-2B2 (SCAVENGER SITE)
RESERVOIR/P.S. ALTERNATIVE



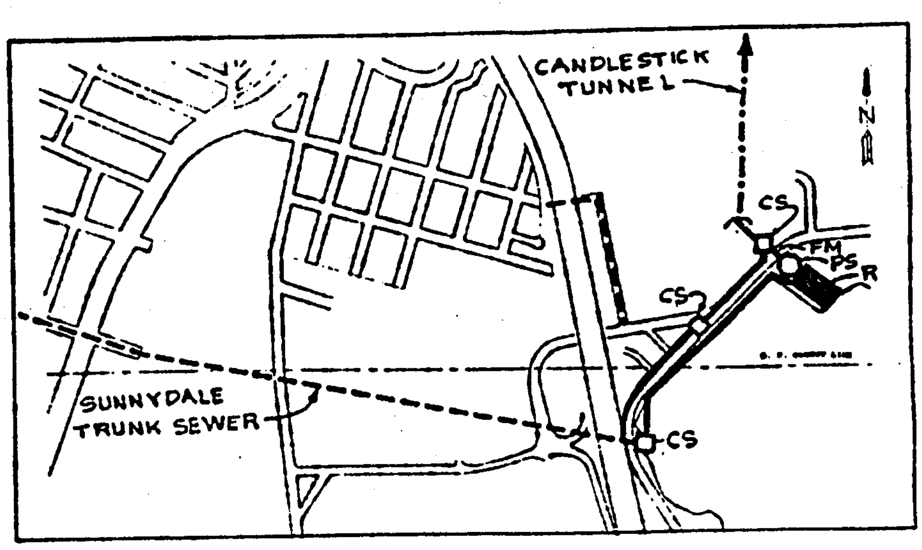
ALT. 2-2A (SCAVENGER SITE)
GRAVITY ALTERNATIVE



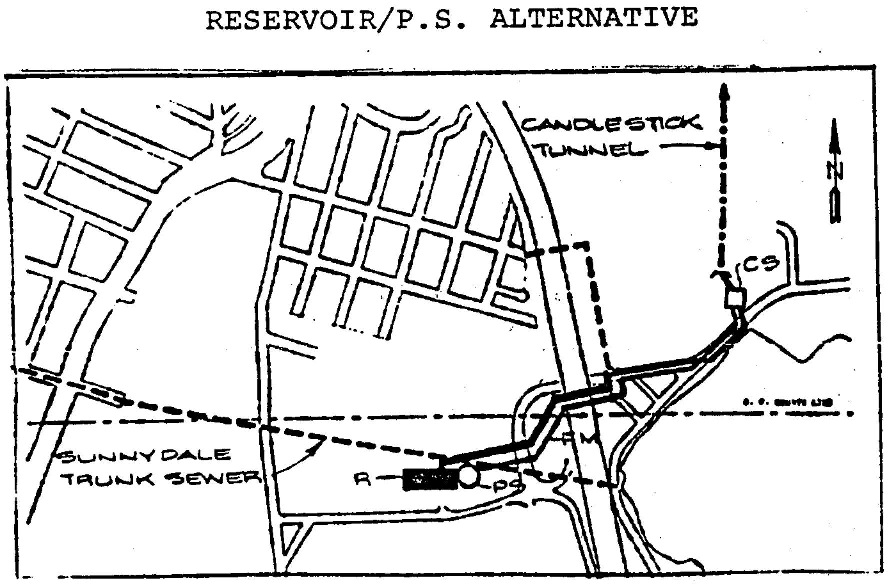
ALT. 2-5 (BAYSHORE FWY. SITE)
RESERVOIR/P.S. ALTERNATIVE



ALT. 2-2B (SCAVENGER SITE)
RESERVOIR/P.S. ALTERNATIVE



ALT. 2-6 (BAY SITE)
RESERVOIR/P.S. ALTERNATIVE



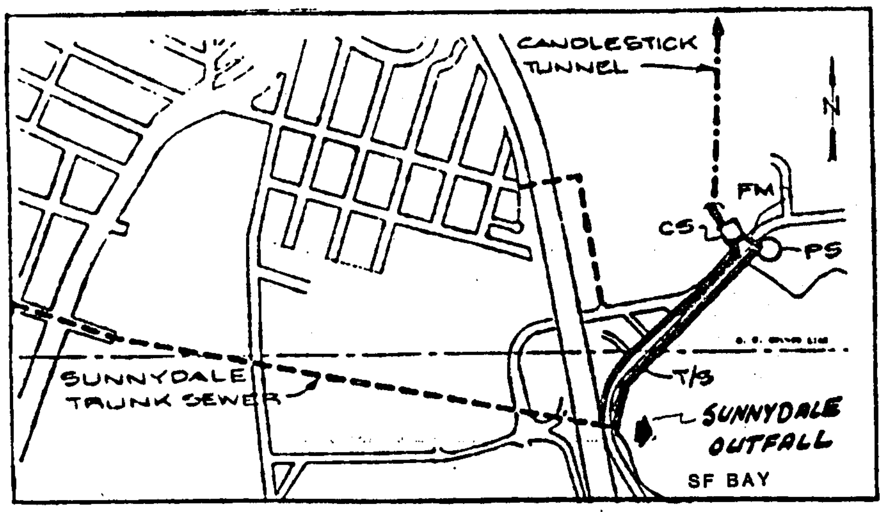
ALT. 2-2B1 (SCAVENGER SITE)
RESERVOIR/P.S. ALTERNATIVE

LEGEND:

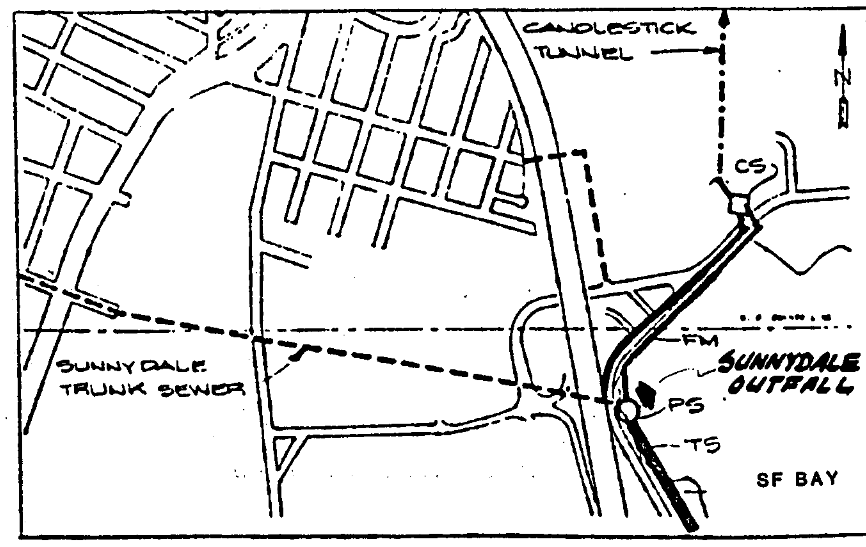
- INTERCEPTOR
- FM FORCE MAIN
- T/S TRANSPORT/STORAGE
- EXISTING SEWER
- EXISTING TUNNEL
- PS PUMP STATION
- LS LIFT STATION
- R RESERVOIR
- CS CONTROL STRUCTURE

FIG. 4-7 SUNNYDALE T/S FACILITIES

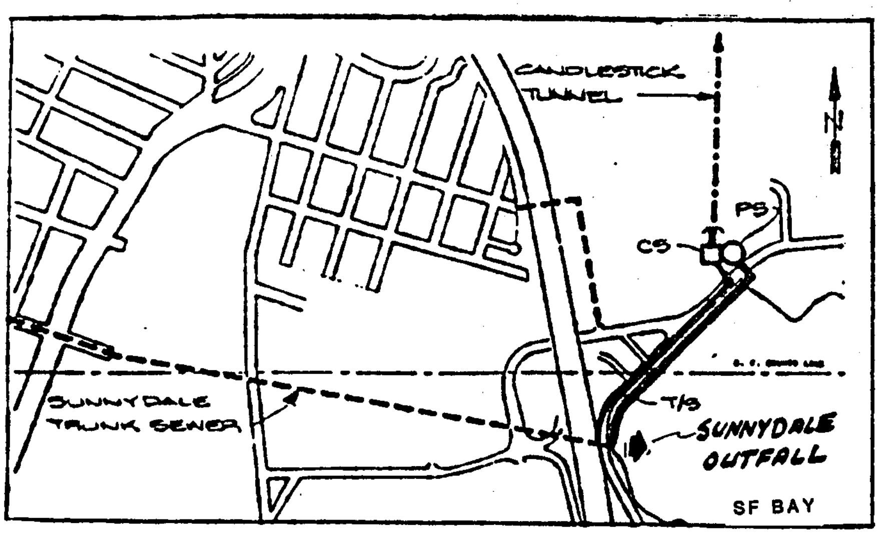
ALT. 2-3A, 2-3B, 2-4 & 2-7



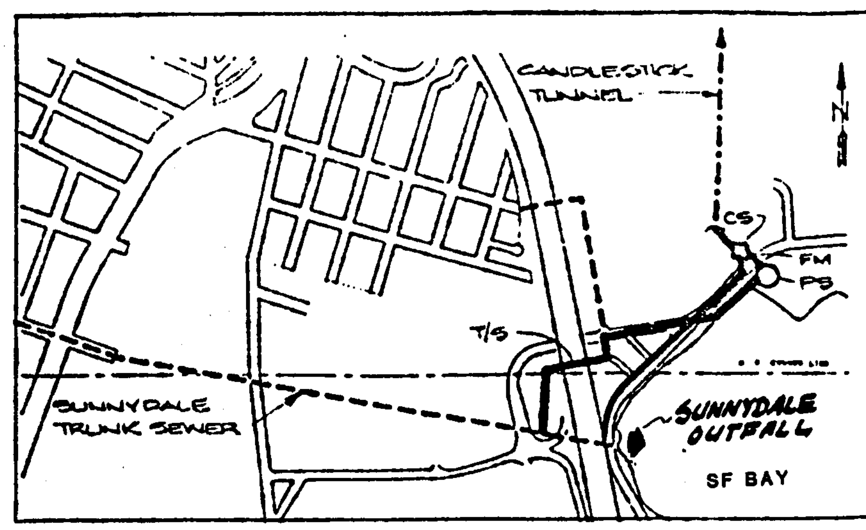
ALT. 2-3A (BAY SITE)
T/S / P.S. ALTERNATIVE



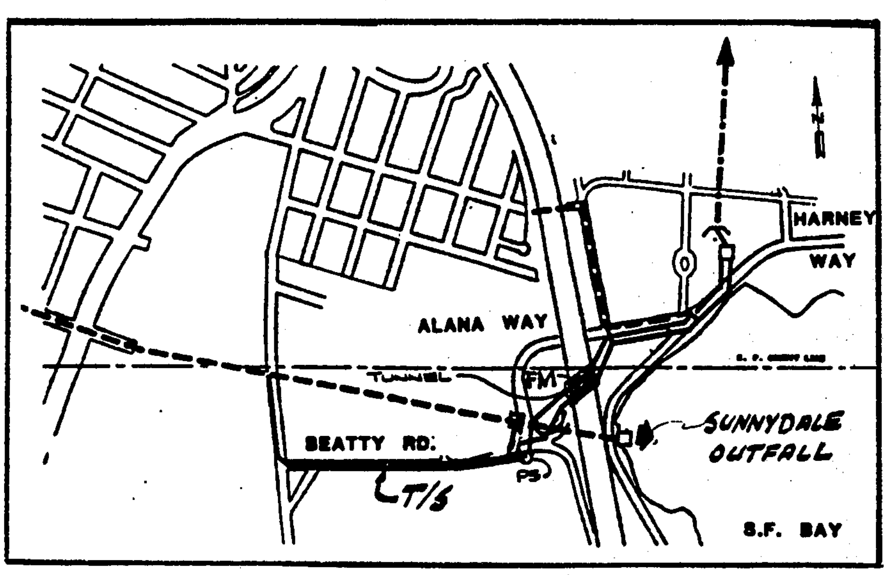
ALT. 2-4 (BAYSHORE FWY. SITE)
T/S / P.S. ALTERNATIVE



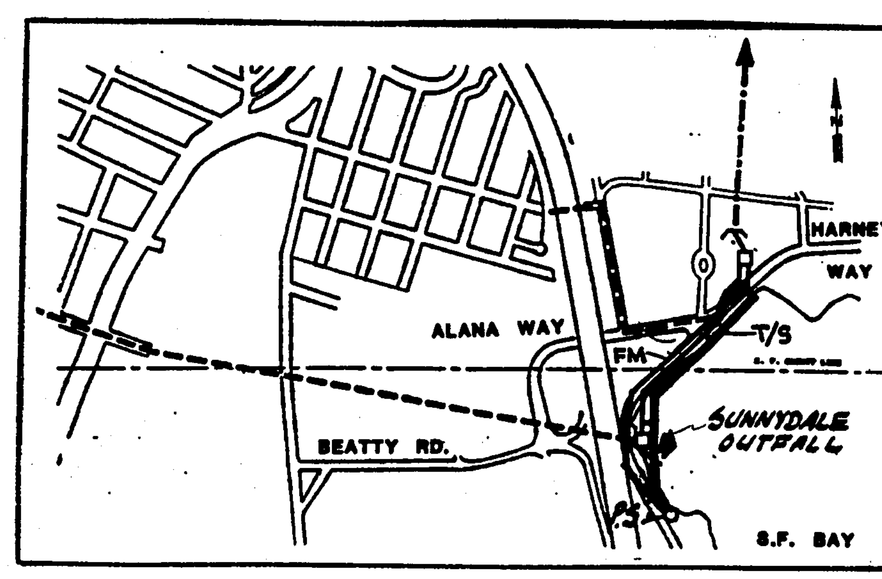
ALT. 2-3B (BAY SITE)
T/S / P.S. ALTERNATIVE



ALT. 2-7 (ALANA WAY SITE)
T/S / P.S. ALTERNATIVE



ALT.2-8 (BEATTY RD. SITE)
T/S/PS ALTERNATIVE

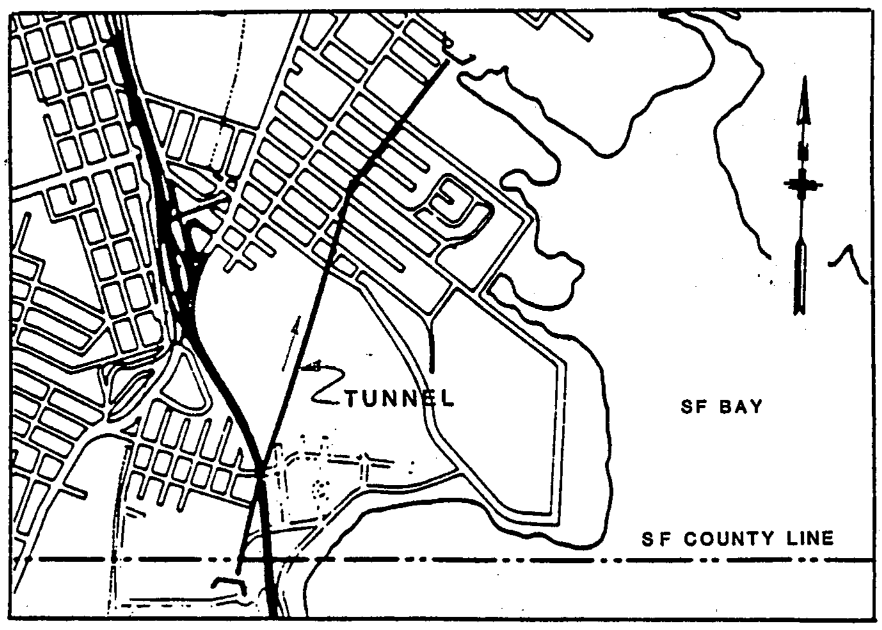


ALT. 2-10 (BAY SITE)
T/S/PS ALTERNATIVE

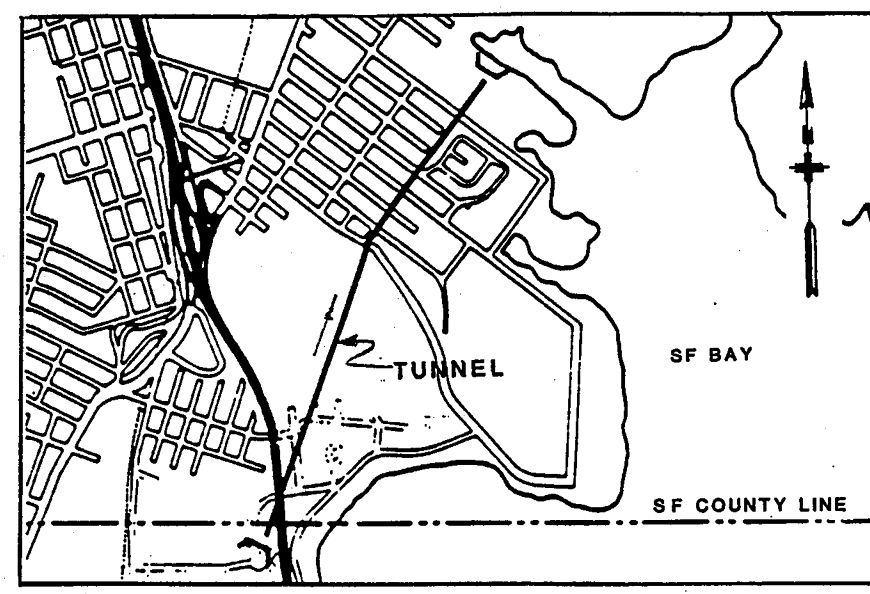
LEGEND:

———	INTERCEPTOR
FM	FORCE MAIN
T/S	TRANSPORT/STORAGE
- - - - -	EXISTING SEWER
—·—·—	EXISTING TUNNEL
PS / LS	PUMP STATION / LIFT STATION
R	RESERVOIR
CS	CONTROL STRUCTURE

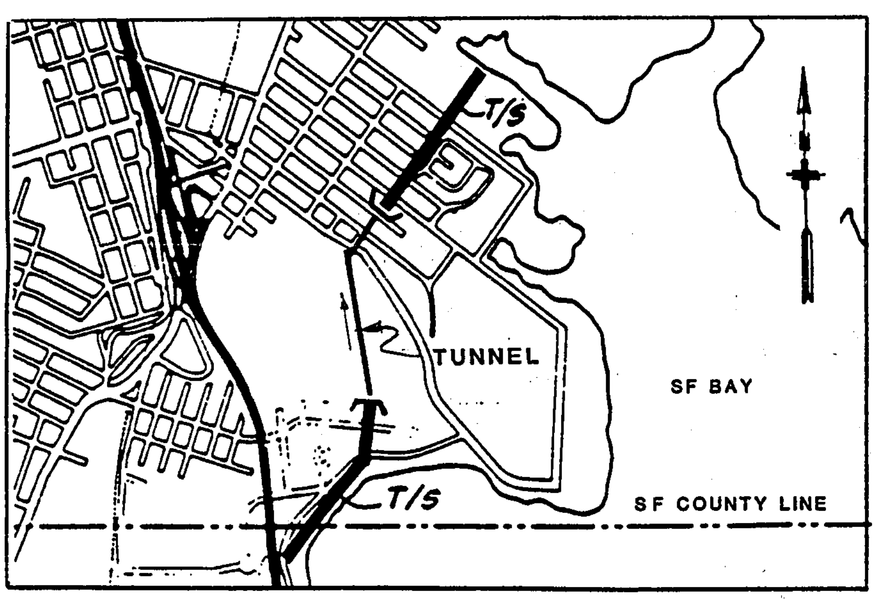
FIG. 4-7a SUNNDALE T/S FACILITIES
ALT. 2-11, 2-12 & 2-13



ALTERNATIVE 2-11
(TUNNEL ALTERNATIVE)



ALTERNATIVE 2-12
(TUNNEL ALTERNATIVE)



ALTERNATIVE 2-13
(TUNNEL ALTERNATIVE)

FIG. 4-7a

No Project Alternative

This alternative is a case in which no action is taken and existing facilities are retained. Obviously, the no project alternative will not reduce storm-related overflows below their present annual frequency of 43 times per year. Thus, National Pollutant Discharge Elimination System (NPDES) permit requirements calling for a reduction of overflows to an average of one per year would be violated. This alternative, therefore, is not retained for further analysis.

Gravity-Dependent Alternatives

- Alternative 2-1 has a 5.7 mg reservoir located on the CECO Site S-2. The area required on the site is currently being used for the storage of construction materials, which may result in relocation problems for the business. When runoff in the Sunnydale watershed exceeds the 60 mgd capacity of the Candlestick Tunnel, the excess flow is diverted by a control structure from the Sunnydale trunk sewer and transported to the reservoir by a proposed 10'w x 10'd box transport sewer with a capacity for 5-year frequency storm.

  When the transport system is full, the control structure on the trunk sewer diverts all flow to the reservoir where sediments settle and floatables are retained in storage by baffles before overflow rises over a weir. The overflow is transported back to the trunk sewer by means of a double 8'w x 6'-6"d box transport sewer and, thence, to the outfall where gates in a control structure are opened to allow discharge into the bay. At the end of the storm when capacity is available in the transport sewer, the stored flow in the reservoir is dewatered by a 50 mgd lift station to meet the present development conditions (see Figure 4-2).

  A new transport sewer is required in this alternative to convey flow from the trunk sewer to the Candlestick Tunnel Portal using a route along Alana Way and Harney Way. This sewer should be sized to handle the potential 60 mgd required to meet the ultimate development conditions. Variations in the alignment outside of the Alana roadway were investigated to avoid disruption of traffic. Alana Way is the only access from the freeway for the large volume of truck traffic generated by the Scavenger transfer station, CECO steel and other industrial enterprises in this area. An alignment outside the roadway would require boring or jacking of the pipe under the freeway. This work would be difficult and costly because of the presence of boulders used in the freeway construction to displace and stabilize the bay mud. Work under the freeway would be subject to getting permits from Caltrans. This alternative is retained for final consideration so that the new alternatives developed in this addendum can be compared to the ABA of the original study.

This gravity-dependent system would require that a separate compartment be constructed in the Yosemite-Fitch (Y-F) structure for transport of the Sunnydale flow to a separate sump at the Griffith Pump Station.

- Alternative 2-2A has a 5.7 mg storage reservoir in the Scavenger Site (S-1) and its operation is the same as Alternative 2-1. The difference of this alternative is that the reservoir is located closer to the Sunnydale Trunk Sewer and, thus, requires shorter transport structures. This alternative is not retained for final consideration because it essentially duplicated Alternative 2-1.

- o <u>Pump-Dependent Alternatives With Reservoir Structure</u>

  <u>Alternatives 2-2B, 2-2B1, and 2-2B2</u> place a 5.7 mg reservoir at various locations in the Scavenger Site (S-1). These alternatives impact the Scavenger facilities and/or operations in various ways. These alternatives were investigated at the request of the owners of the Scavenger site to find the least disruptive location. Alternative 2-2B would displace the truck and employee parking/storage. Alternative 2-2B1 alleviates the transfer truck parking/storage problem but removes some old structures used for garbage truck parking, which would need to be replaced. Alternative 2-2B2 uses an area which is currently used by the Scavenger operation for recycling and storage. Of these three options, Alternative 2-2B1 is retained for further evaluation since it has been agreed to by both the owner and CWP as having the least impact on the business occupying the site and minimizes the length of gravity sewers to intercept the watershed flows.

  In Alternative 2-2B1, storm flows which do not exceed the capacity of Candlestick Tunnel would gravitate to the Yosemite-Fitch Facility (Y-F). The gravity flow capacity of the Candlestick Tunnel is 60 mgd when the water level in Y-F is below -18 feet and decreases as the Y-F water level continues to rise above -18 feet. When the Sunnydale storm runoff exceeds 60 mgd the excess flow would discharge into the reservoir by way of a control structure on the Sunnydale Trunk Sewer. The dewatering of the stored flows at a rate of 50 mgd would begin as soon as the water level in the Sunnydale reservoir is high enough to activate the pumps. The pumped flow would be discharged to the control structure near the tunnel portal via a proposed 48" diameter force main. As a result of hydrostatic pressure from the force main discharge and the rising water level in Y-F, the flap gate in the control structure would close and all the Sunnydale runoff would be diverted into the reservoir. When the flap gate has closed, flows from the Little Hollywood and Executive Park area would be transported to the reservoir via a 60" diameter sewer by reversing the flow direction.

When the storage facility becomes full, excess flows would be routed under baffles to remove floatables. This excess runoff would then overflow a weir and discharge through the Sunnydale Outfall into the Bay. A control structure at the outfall would divert flows to the Candlestick Tunnel at the beginning of a storm up to the rate of 60 mgd and would discharge into the Bay only when the reservoir weir starts to overflow.

<u>Alternative 2-5</u> places a 5.7 mg reservoir in the Bayshore Freeway Site (S-7) at the discharge point of the existing Sunnydale Outfall. The proposed facilities and operation of this alternative is similar to alternative 2-2B except that the proposed force main from the reservoir to the tunnel portal is shorter. Since the reservoir structure would be defined by the

BCDC as major filling of the Bay, the agency has given its objection to this alternative and would not issue a permit for its construction unless no other upland location is available for its construction. Since there are other upland locations, this alternative is dropped from consideration in the final analysis.

Alternative 2-6 places a proposed 5.7 mg reservoir in the Bay Site (S-8) in lands owned by State Parks. This alternative extends the Sunnydale trunk sewer with approximately 1500 feet of 108 inch diameter transport pipe to the proposed reservoir, minimizes the length of force main from the pumping station to the tunnel portal, and avoids major filling of the Bay. Since the 108 inch diameter pipe does not have quiescent flow as in a transport storage structure, the existing outfall would have to be relocated to the proposed reservoir in order to obtain effective removal of settleable solids and floatables. Secondly, this alternative raises the hydraulic grade controls of the sewer system by virtue of the energy losses through the additional 1,500 feet of pipe. This loss is approximately 3 feet for the 108 inch diameter transport pipe. Pipes of larger diameter would reduce the energy losses, but not adequately until sizes approximating the transport-storage structure similar to Alternative 2-3A, described below, is reached. The added losses would cause flooding of upstream areas. Because of these two major reasons which could require large amounts of money to correct, this alternative is dropped from consideration in the final analysis.

ALTERNATIVE 2-11 is a Tunnel Alternative.

A 12 feet diameter tunnel intercepts the flows from Sunnydale trunk sewer near Alana Way. The flows are then transported by gravity to Yosemite/Fitch sewer system at Yosemite and Ingalls.

This alternative would require a much deeper Yosemite/Fitch system which is not compatible with the soon to be constructed system. It is removed from further consideration.

ALTERNATIVE 2-12 is similar to Alternative 2-11. A 12 feet diameter tunnel intercepts flows from Sunnydale trunk sewer. The flows are then transported by gravity to the Yosemite/Fitch system at Bancroft and Hawes. This alternative would also require a much deeper Yosemite/Fitch system. It is removed from further consideration.

ALTERNATIVE 2-13 is also a Tunnel Alternative. A transport/storage box sewer along the shoreline intercepts the flows from the Sunnydale trunk sewer at the existing Sunnydale Outfall. A 12 feet diameter tunnel connects this transport/storage sewer with another transport/storage sewer in Hawes Street.

In this alternative, there would be major traffic impacts caused by construction activities on Executive Park Blvd. and Hawes. Based on community and business disruption and system inflexibility, this alternative is removed form further consideration.

- Pump-Dependent Alternatives With Transport-Storage Structure

  Alternative 2-3A places a 5.7 mg transport-storage (T-S) facility and a pumping station in the Bay Site. The proposed T-S structure is located on the shoreline band alongside Harney Way and the pumping station is located in the main body of the Candlestick Point Recreation area. Storm flows which do not exceed the capacity of Candlestick Tunnel will gravitate to the Yosemite-Fitch Facility (Y-F). The gravity flow capacity of the Candlestick Tunnel is 60 mgd when the water level in Y-F is below -18 feet. When the Sunnydale storm runoff exceeds 60 mgd, the excess flow will discharge into the transport storage structure by way of a control structure on the Sunnydale Trunk Sewer. The dewatering of the stored flows at a rate of 50 mgd would begin as soon as the water level in the Sunnydale pump station sump is high enough to activate the pumps. The pumped flow would be discharged to the control structure near the tunnel portal via a proposed 48" diameter force main. As a result of hydrostatic pressure from the force main discharge and the rising water level in Y-F, the flap gate in the control structure will close and all the Sunnydale runoff will be diverted into the transport storage structure. Flows exceeding the storage capacity of the system would pass over a baffled control weir to remove floatables before discharging to the Bay through a new structure in the general location of the existing outfall. A length of transport sewer is required on Harney Way to enlarge the existing sewer system so that it has the capacity to carry the 60 mgd capacity of the tunnel. This alternative is retained for final analysis.

Alternative 2-3B, investigated at the request of State Parks, is identical to Alternative 2-3A except that it locates the pumping station on private property owned by Campeau Corp. (San Francisco Executive Park). All considerations are much the same as 2-3A. However, placement of the pump station on Campeau property poses some additional problems. The Campeau Corp. has just received final EIR certification for additional development of San Francisco Executive Park. Construction of the pumping station at this site would place it adjacent to the planned hotel. Although this property can be obtained through eminent domain, acquisition would be quite costly if it necessitates changes to Campeau's development plans. This alternative is not retained for final analysis because of these adverse effects to private property.

Alternative 2-4 locates the proposed T-S and pumping station facility in the Bayshore Freeway Site. The force main would extend from the pumping station location near the existing Sunnydale Outfall to the Candlestick Tunnel portal. The transport sewers in Harney Way leading to the tunnel portal needs to be enlarged to be capable of delivering 60 mgd to the tunnel similar to Alternative 2-3A. The operation of the system is identical to Alternative 2-3A. The T-S and/or pumping station structure will cause major filling of the Bay on this site and BCDC will object to this alternative unless no upland locations are available for consideration. Furthermore, because of the poor soils conditions at this site, it would be much more difficult to provide adequate foundation support than for Alternative 2-3A. Since this alternative so closely duplicates Alternative 2-3A, and has the added drawbacks described above, it is not retained for final analysis.

Alternative 2-7 locates the proposed T-S facility of approximately 1500 feet length in an alignment alongside and in Alana Way and approximately 400 feet in the shoreline along Harney Way, between the Sunnydale Trunk sewer and the proposed pumping station located in State Park property. Various options for crossing the freeway were investigated. These included a T-S box or a circular conduit in the Alana roadway and a jacked or tunnelled structure underneath the freeway. Open trench construction in the 36 foot wide by 180 foot long Alana Way freeway underpass would disrupt the main freeway access route for this area of the City. Open trench excavation would also undermine the spread footing bridge support of the freeway. The headroom for driving of trench support walls or piles would be severely limited under the freeway bridge structure crossing Alana Way. Construction of a jacked or tunneled structure under the freeway would face the problem of removing boulders which were used to displace and stabilize the soil during the construction of the freeway. Because of these serious technical problems and since this alternative provides no special operational advantage over Alternative 2-3A, this alternative was not retained for final analysis.

Alternative 2-8 locates the proposed T-S sewer of approximately 1,350 feet length in Beatty Road between Tunnel Ave. and Alana Way with a pumping station at the end near Alana Way. A proposed 108" diameter pipe in Tunnel Ave. connects the existing Sunnydale Trunk Sewer and the proposed T-S sewer. Another 108" diameter pipe connects the existing Sunnydale Trunk sewer and the T-S sewer near Alana Way.

Storm flows which do not exceed the capacity of Candlestick Tunnel would gravitate to the Yosemite-Fitch Facility when the Sunnydale storm runoff exceeds the Candlestick Tunnel capacity, it would overflow into the T-S sewer by way of control structures on the Sunnydale Trunk sewer. The flows from Executive Blvd. would also be diverted into the T-S sewer through a 60" diameter pipe. The flow in the T-S sewer would then be pumped to a control structure near the tunnel portal via a proposed 48" diameter force main. Both the 48"Ø force main and 60" diameter pipe would be tunneled or jacked under the Bayshore Freeway. This alternative is retained for final analysis.

Alternative 2-10 is similar to Alternative 2-3A, except the pumping station is located to the southerly end of the transport storage structure on Santa Fe Pacific property instead of the State Parks; and a longer force main has to be provided. This alternative is retained for final analysis.

Summary

In summary, five of the seventeen initial alternatives were selected for final analysis. These five alternatives, 2-1, 2-2B1, 2-3A, 2-8 and 2-10 meet the conditions for the required facilities and the planning criteria. The remaining 12 alternatives were not included for further consideration because of impacts to private property, traffic, poor soil conditions, or failure to meet governmental requirements.

5. ANALYSIS OF FINAL ALTERNATIVES

ANALYSIS OF FINAL ALTERNATIVES

Plans, profiles, and flow schematics of the final alternatives follow the narrative description of each of these alternatives. Control structures, in which weirs, gates, or similar devices are used to control flow rates, are indicated on the plans. Junction boxes, which are structures that connect new to existing sewers and transport/storage structures to existing sewers, are also shown on the plans. The flow schematics indicate dry weather and wet weather flows. The operation of the system is such that when the associated storage is utilized, no more than one overflow per year will occur on the long term average.

Alternative 2-1:

The major elements of Alternative 2-1 are shown on Figure 5-1 and identified in Table 5-1. Profiles for Alternative 2-1 are shown on Figure 5-2 and a schematic flow diagram is presented on Figure 5-3. The control system alternative routes are shown on Figure 5-1a. The number of overflows in the Sunnydale area would be reduced by an off-line storage of wet weather flow peaks in a covered reservoir. Dry weather flow would continue to pass through the existing interceptor to the Candlestick tunnel and into the Yosemite Basin.

During wet weather, 60 mgd would be transported by gravity through existing and new interceptors to the Candlestick tunnel and subsequently to the Yosemite drainage basin. The Sunnydale Overflow would be controlled by a weir at the reservoir and a weir and gates at the overflow control structure. The location of the existing overflow point would not be changed.

Wet weather would be transported by gravity to the Griffith Pump Station in the Yosemite Basin. Since flows are by gravity from Sunnydale in this alternative, the hydraulic grade line of the Sunnydale flow at the Griffith Pump Station must be much lower than that of the Yosemite flow. Therefore, the Sunnydale flow would have to be transported to the new Griffith Pump Station in a separate, lower compartment of the transport/storage facility so that the 60 mgd gravity flow from the Sunnydale Basin can be pumped directly to the Hunters Point tunnel without going into storage. This approach also means that the Griffith Pump Station maximum capacity of 120 mgd may not be achieved until the flow has reached the pump station.

Figure 5-1a shows the alternative routes of the communication cable way for the control system for the Sunnydale Facilities. Route A was selected because this route is 1,200 feet shorter than Route B resulting in lower costs.

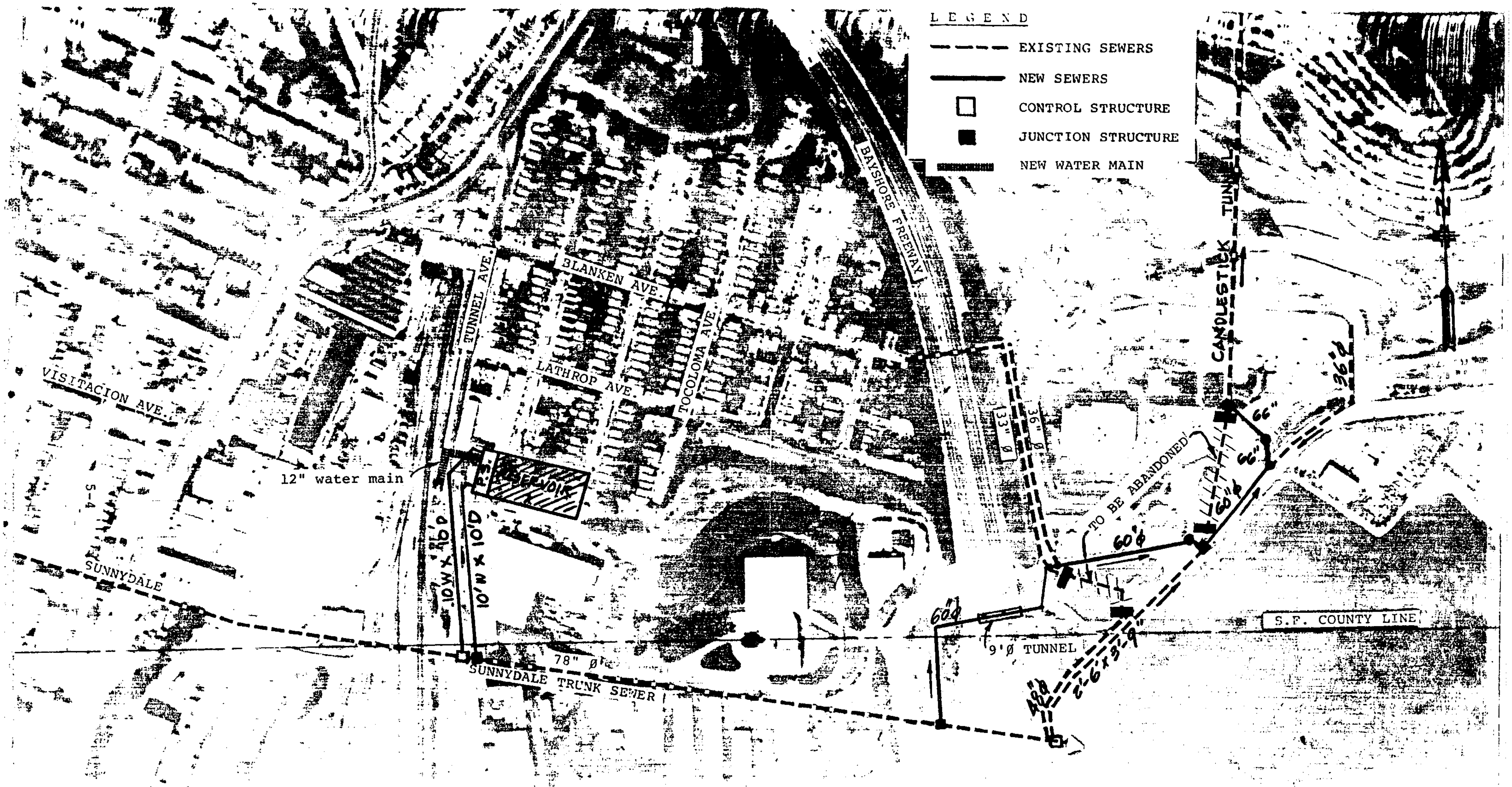


FIGURE 5-1

SUNNYDALE FACILITIES
ALTERNATIVE 2-1 PLAN

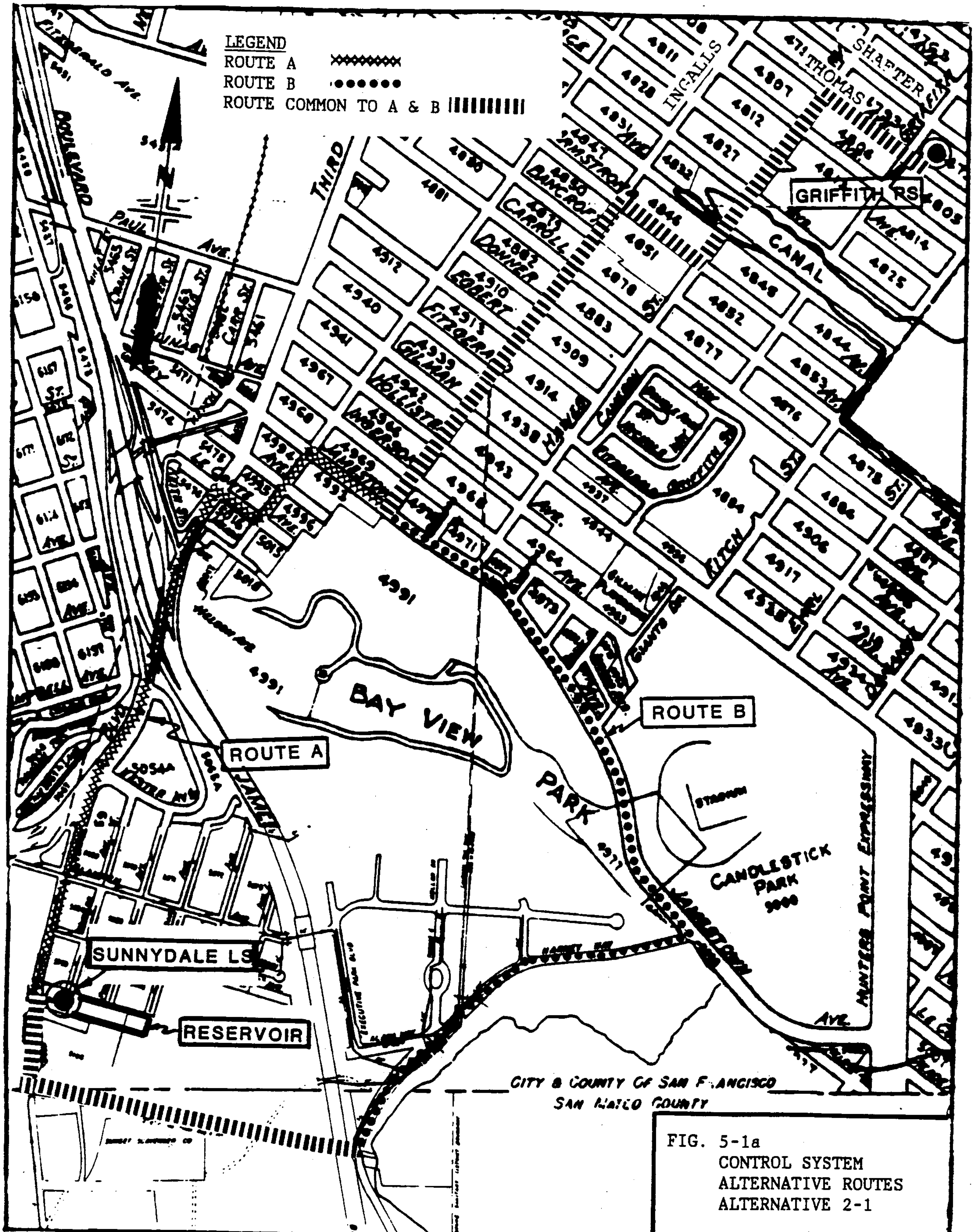


FIG. 5-1a
CONTROL SYSTEM
ALTERNATIVE ROUTES
ALTERNATIVE 2-1

TABLE 5-1 Major Elements, Alternative 2-1

Element	Location	Dimensions	Capacity	Length, Feet
Reservoir	Site S-2	400' X 100' X 21'	5.7 mil gal	750
Lift Station		100'X40'X70'[1]	50 mgd	
Interceptor	Tunnel Ave.	10' X 10'		750
	Tunnel Ave.	10' X 10'		650
	Easement	66"Ø		150
	Easement	66"Ø		50
	Harney	60"Ø		500
	Alana Way	60"Ø		1,000
Structures		9'Ø Tunnel or Jacked Pipe		200
		Control Structure		2 EA
		Junction		4 EA
Control System	(2)	(2)		12,900

(1)Odor control & ventilation room included.

(2)As per Fig. 5-1a, Route A

Fiberoptics inside 4"Ø PVC	=	12,900 ft.	
4"Ø PVC	=	8,900 ft.)	Total 12,900 ft.
4"Ø PVC (by others)	=	4,000 ft.)	

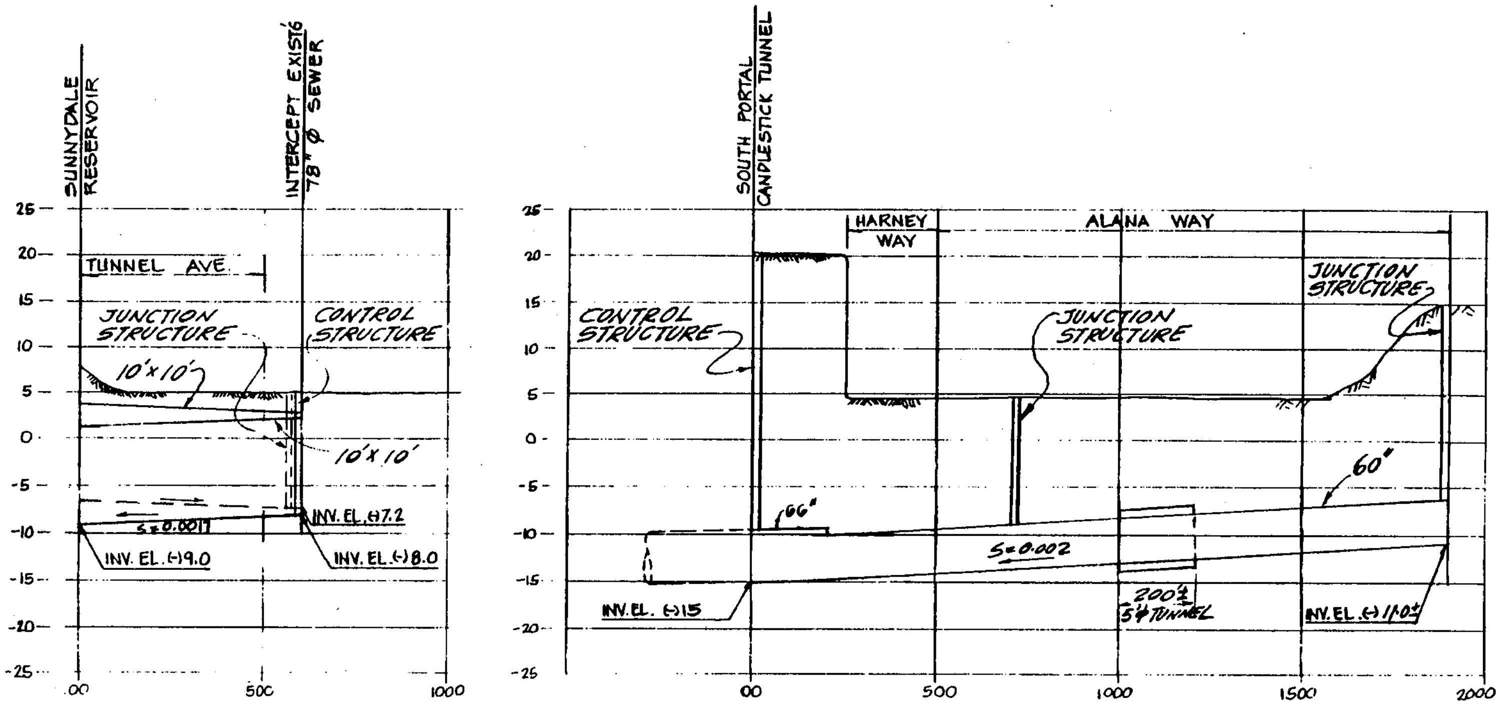
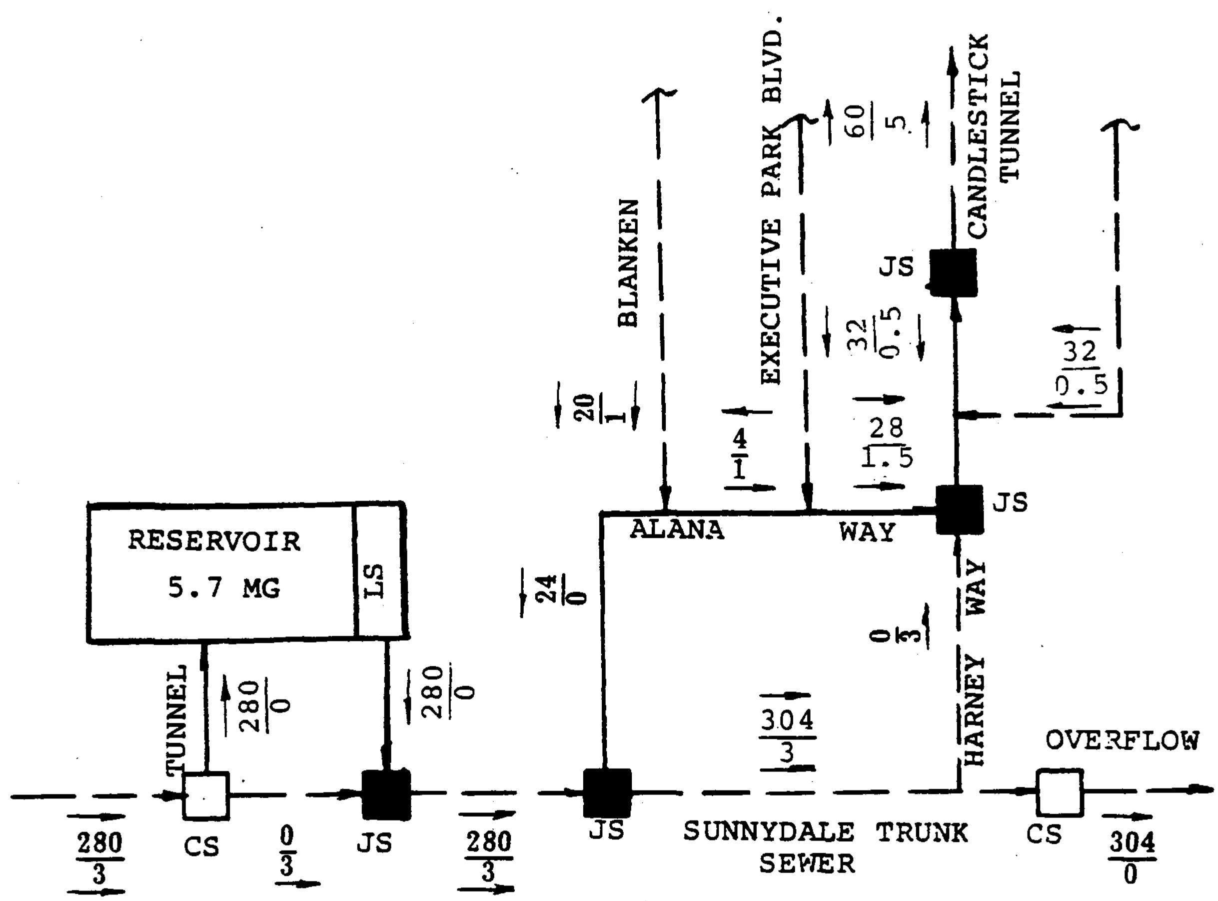


FIGURE 5-2

SUNNYDALE FACILITIES
ALTERNATIVE 2-1 PROFILE



NOTE SCHEMATIC SHOWS WW FLOW QUANTITIES AND DIRECTIONS AFTER STORAGE VOLUME IS FULL

LEGEND

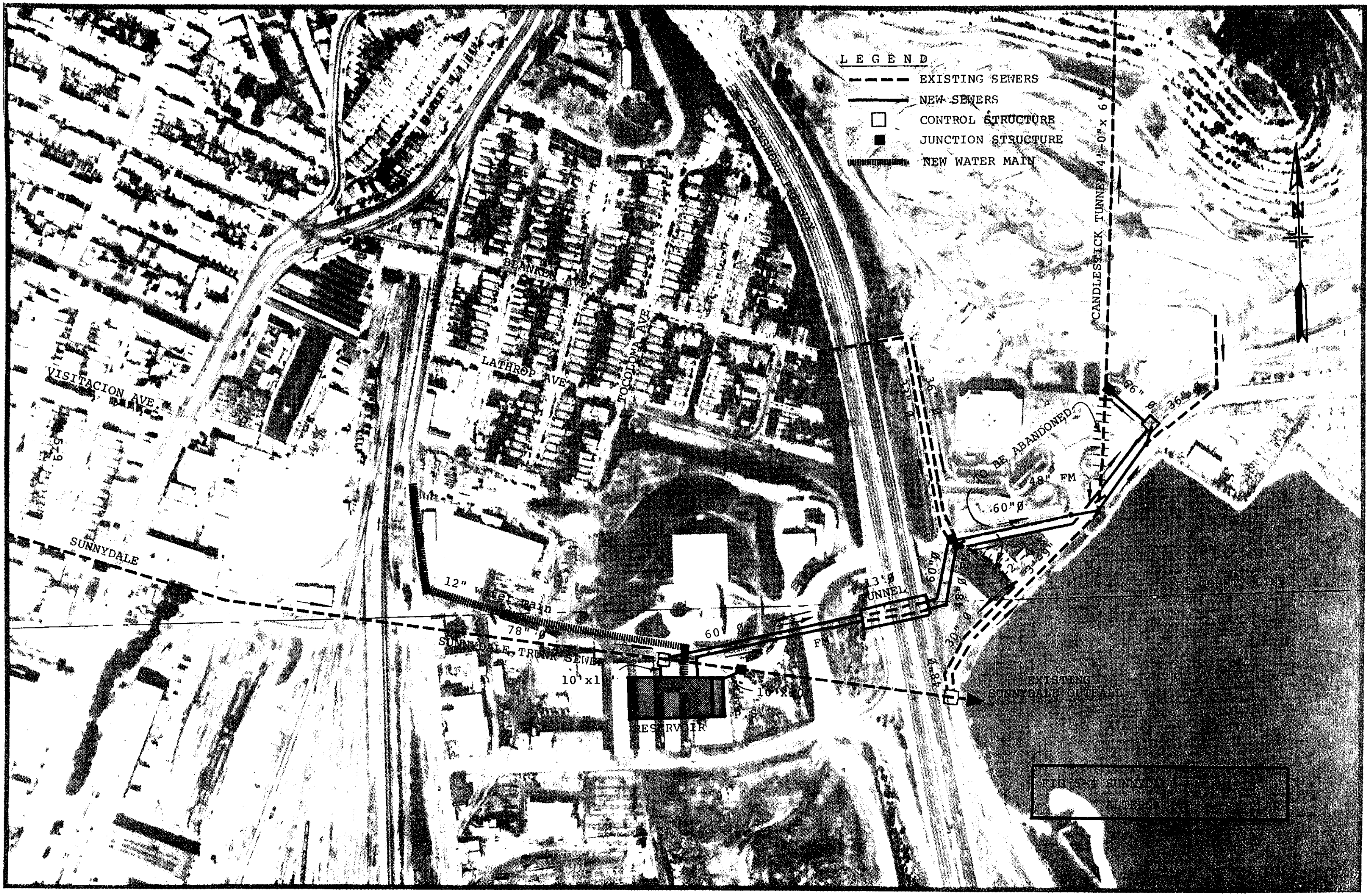
■	JS	JUNCTION STRUCTURE
□	CS	CONTROL STRUCTURE
— — —		EXISTING SEWER
———		PROPOSED SEWER
	LS	LIFT STATION
280		WET WEATHER FLOW, MGD (5-YR. STORM)
3		AVE. DRY WEATHER FLOW, MGD

FIG. 5-3
SCHEMATIC FLOW DIAGRAM
ALTERNATIVE 2-1

Alternative 2-2B1:

Major elements of Alternative 2-2B1 are shown on Figure 5-4 and identified in Table 5-2. Profiles and details for Alternative 2-2B1 are shown on Figures 5-5 and 5-6 and a schematic flow diagram is presented on Figure 5-7. The control system alternative routes are shown on Figure 5-4a of which Route B was selected due to its shorter distance. Dry weather would pass through the existing interceptor to the Candlestick tunnel and into the Yosemite Basin. The number of overflows in the Sunnydale area would be reduced by an off-line storage of wet weather flows in a covered reservoir.

During wet weather, storm flows which do not exceed the capacity of Candlestick Tunnel will gravitate to the Yosemite-Fitch Facility (Y-F). The gravity flow capacity of the Candlestick Tunnel is 60 mgd when the water level in Y-F is below -18 feet and decreases as the Y-F water level continues to rise above -18 feet. When the Sunnydale storm runoff exceeds the 60 mgd capacity of the Candlestick Tunnel, the excess flow would go into storage in the reservoir by way of a control structure on the Sunnydale Trunk Sewer. The dewatering of the stored flows by the pumping station at a rate of 50 mgd would begin as soon as the water level in the Sunnydale reservoir is high enough to activate the pumps. The pumped flow would be discharged to the control structure in Harney Way via a proposed 48" diameter force main. From the control structure, the flow gravitates to the tunnel portal via a 66" diameter gravity main. As a result of hydrostatic pressure from the force main discharge and the rising water level in Y-F, the flap gate in the control structure would close and all the Sunnydale runoff will be diverted into the reservoir. When the gate closes, flows from the Little Hollywood and Executive Park area would be transported to the reservoir via a 60" diameter sewer. When the reservoir fills, the excess flow would discharge under a baffle and over a weir. The control structure at the existing outfall would discharge the excess flows into the Bay.


LEGEND
EXISTING SEWERS
NEW SEWERS
CONTROL STRUCTURE
JUNCTION STRUCTURE
NEW WATER MAIN
CANDLESTICK TUNNEL 4'-0" x 6'
BLANKEN AVE
TOCOLOMA AVE
LATHROP AVE
VISITACION AVE
SUNNYDALE
12" water main
78" Ø
SUNNYDALE TRUNK SEWER
10'x1
60" Ø
FM
13' Ø TUNNEL
60" Ø
48" FM
TO BE ABANDONED
36" Ø
66"
30" Ø
48" Ø
10'x10'
P.S.
RESERVOIR
EXISTING SUNNYDALE OUTFALL

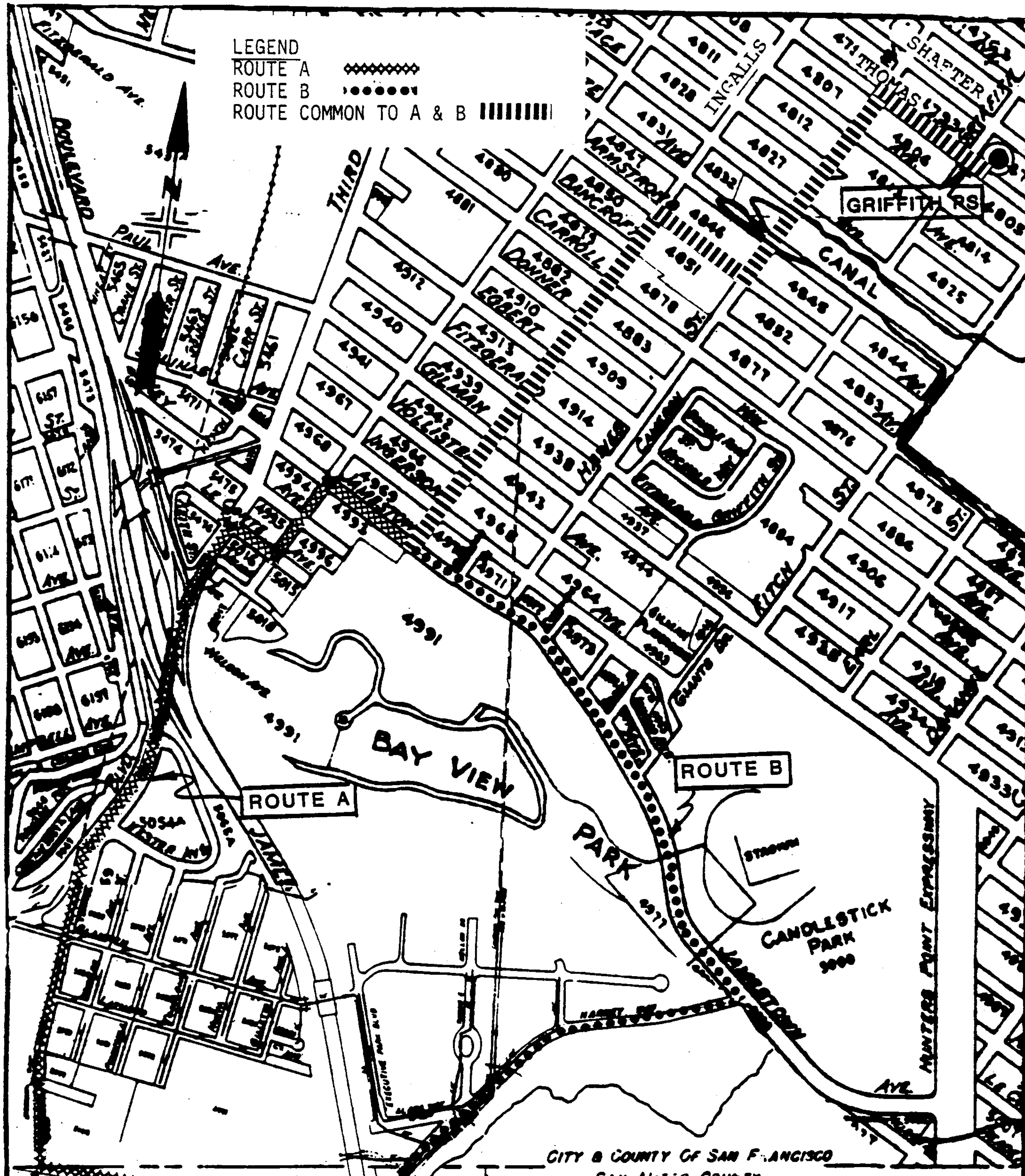


FIG. 5-4a
CONTROL SYSTEM
ALTERNATIVE ROUTES
ALTERNATIVE 2-2B1

Table 5-2 Major Elements, Alternate 2-2B1

Element	Location	Dimension	Capacity	Length, Feet
Reservoir	Site S-1	320' x 100' x 42.5'	5.7 mil gal.	
Pumping Station		100'x40'x70'[(1)]	50 mgd	
Interceptor	Easement	10 ft x 10 ft		40
	Easement	10 ft x 10 ft		70
	Easement	66"Ø		150
	Easement	66"Ø		50
	Easement	60"Ø		1250
	Alana Way	60"Ø		550
	Alana Way	13"Ø tunnel		200
	Harney Way	60"Ø		300
Force Main	Easement	48"Ø		1260
	Alana Way	48"Ø		450
	Harney Way	48"Ø		430
Structures		Control Structure		3 EA
		Junction Structure		3 EA
Control System	(1)	(1)		12,400

(1) Odor control & ventilation room included.
(2) As per Fig. 5-4a, Route B

Fiberoptics inside 4"Ø PVC = 12,400 ft.
4"Ø PVC = 8,400 ft.) Total 12,400 ft.
4"Ø PVC (by others) = 4,000 ft.)

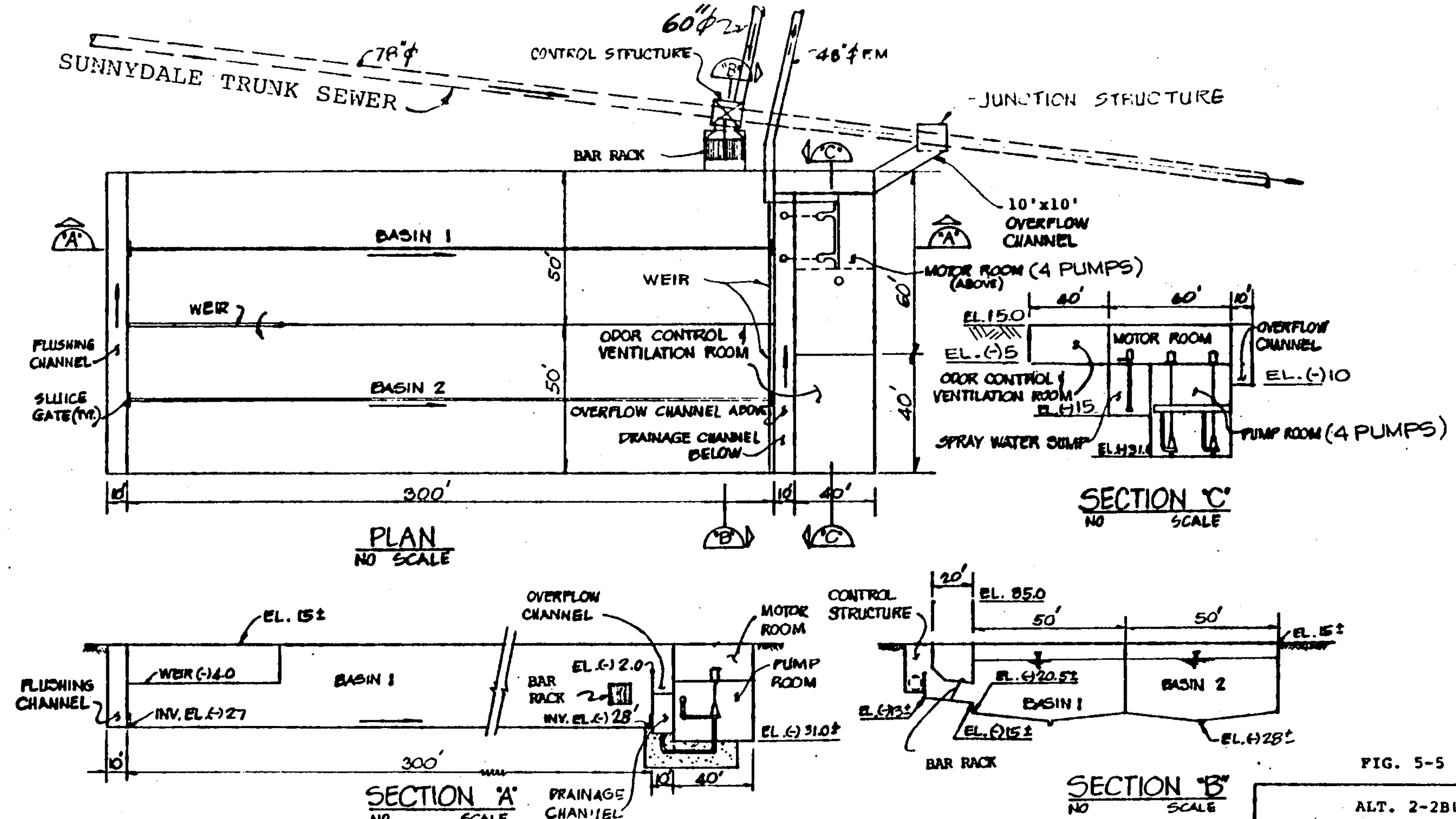


FIG. 5-5

ALT. 2-2B1
RESERVOIR & PUMP STATION
PLAN & SECTIONS

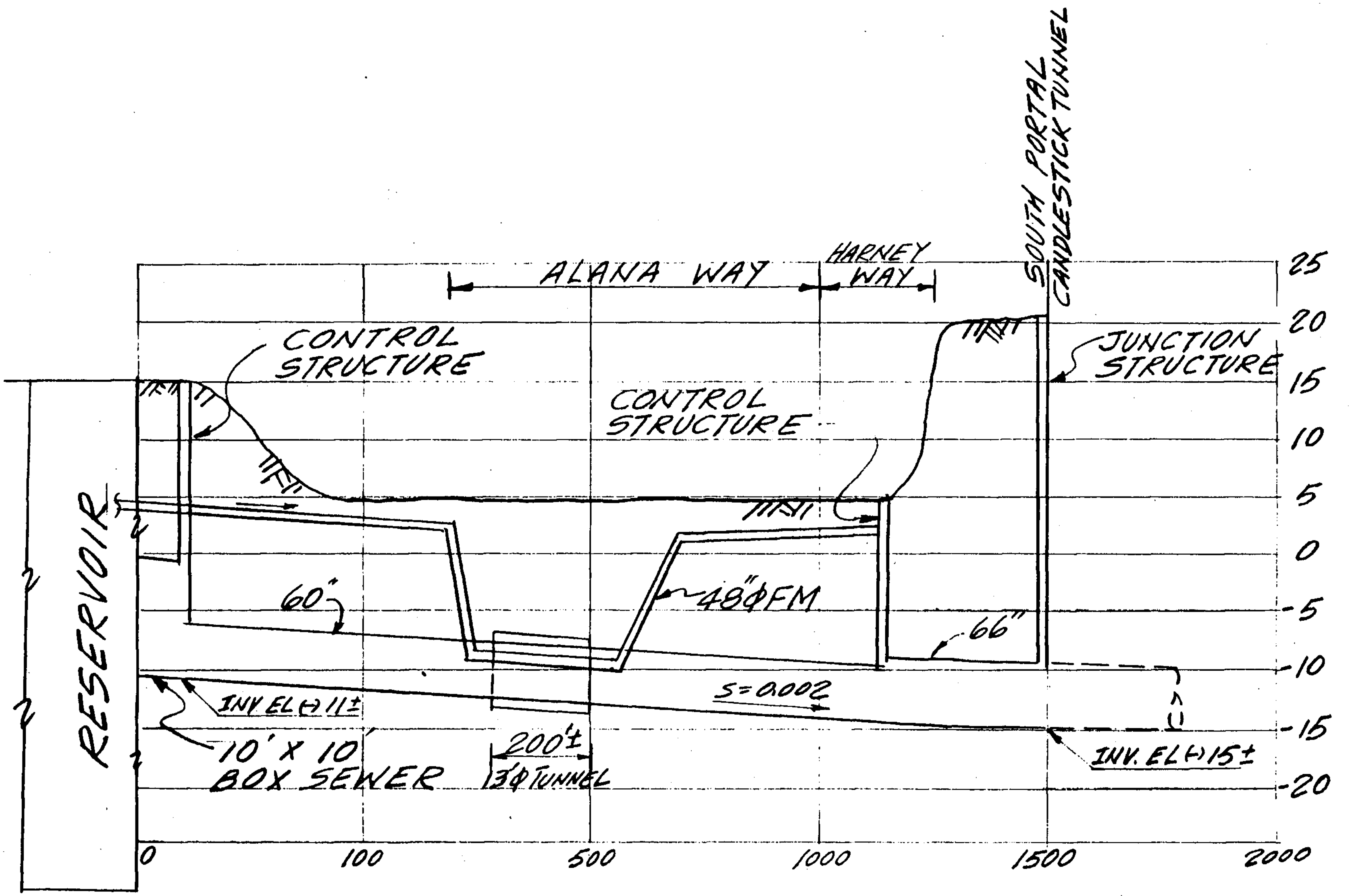
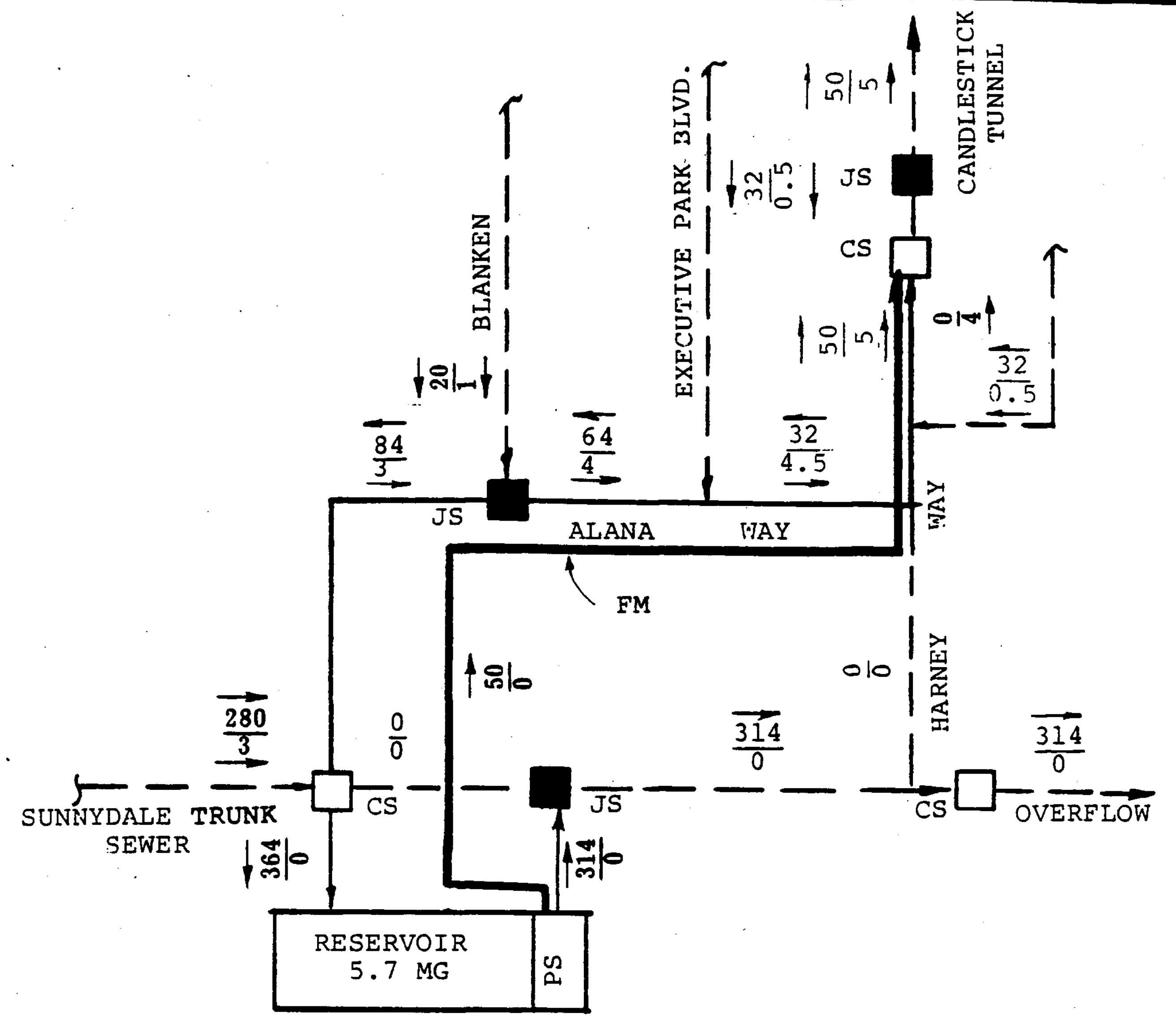


FIGURE 5-6

SUNNYDALE FACILITIES
ALTERNATIVE 2-2B1 PROFILE



LEGEND

■	JS	JUNCTION STRUCTURE
□	CS	CONTROL STRUCTURE
— — —		EXISTING SEWER
———		PROPOSED SEWER
FM		PROPOSED FORCE MAIN
	PS	PUMP STATION
280		WET WEATHER FLOW, MGD (5-YR. STORM)
3		AVE. DRY WEATHER FLOW, MGD

NOTE SCHEMATIC SHOWS WW FLOW QUANTITIES AND DIRECTIONS AFTER STORAGE VOLUME IS FULL

FIG 5-7
SCHEMATIC FLOW DIAGRAM
ALTERNATIVE 2-2B1

The Sunnydale wet weather flow would join with the Yosemite-Fitch runoff in the Yosemite Basin storage facility. This total flow would be dewatered from the beginning of the storm at the full 120 mgd capacity of the Griffith Pump Station.

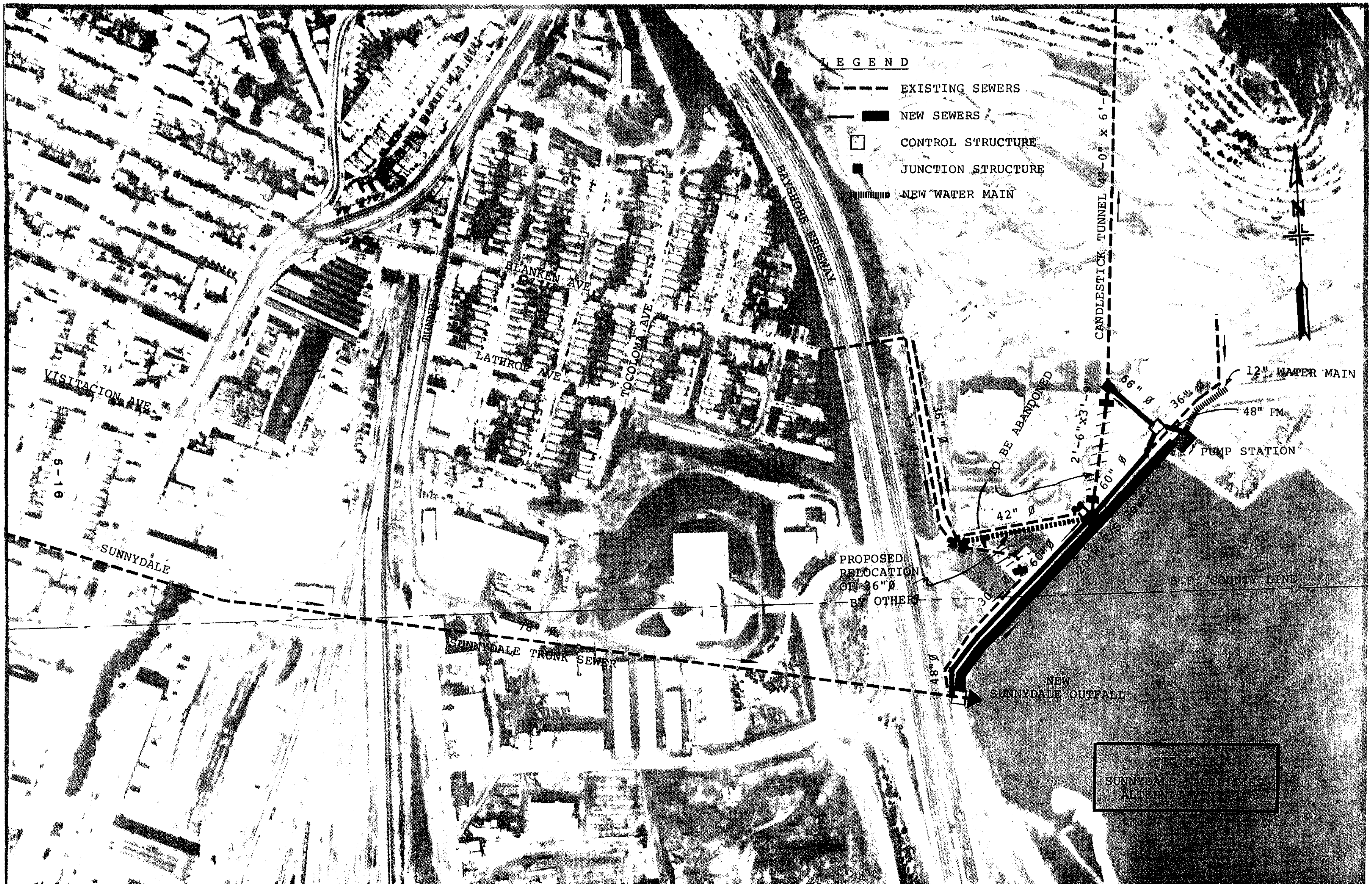
Alternative 2-3A:

Major elements of Alternative 2-3A are shown on Figure 5-8 and identified in Table 5-3. Profiles and details for Alternative 2-3A are shown on Figures 5-9 and 5-10 and a schematic flow diagram is presented on Figure 5-11. The control system alternative routes are shown on Figure 5-8a of which Route B was selected due to its shorter distance. Dry weather flows would pass through the existing and/or new interceptors to the Candlestick tunnel and then to the Y-F basin. The number of overflows in the Sunnydale area would be reduced by the storage of wet weather flows in a transport-storage structure.

During wet weather, flows would be initially transported by gravity through the existing interceptor and new 60" and 66" diameter sewers to the Candlestick tunnel. These storm flows which do not exceed the capacity of Candlestick tunnel will gravitate to the Yosemite-Fitch Facility (Y-F). The gravity flow capacity of the Candlestick Tunnel is 60 mgd when the water level in Y-F is below -18 feet and decreases as the Y-F water level continues to rise above -18 feet. When the

Sunnydale storm runoff exceeds the 60 mgd capacity of the Candlestick Tunnel, the excess flow will discharge into the reservoir by way of a control structure on the Sunnydale Trunk sewer. The dewatering of the stored flows by the pumping station at a rate of 50 mgd would begin as soon as the water level in the Sunnydale reservoir is high enough to activate the pumps. The pumped flow would be discharged to the control structure at the tunnel portal via a proposed 48" diameter force main. As a result of hydrostatic pressure from the force main discharge and the rising water level in Y-F, the flap gate in the control structure would close and all the Sunnydale runoff would be diverted into the reservoir. When the gate closes, flows from the Sunnydale Trunk sewer, Little Hollywood and Executive Park area would overflow at a control structure in Harney Way into the transport-storage structure. When the transport-storage structure becomes full, excess flows would be screened by baffles to prevent release of floatables and then discharged into the Bay over a weir structure and new outfall structure located in the vicinity of the existing Sunnydale Outfall.

The Sunnydale wet weather flow transported through the Candlestick Tunnel would join with the Yosemite-Fitch runoff in the Yosemite Basin storage facility. The total flow from both watersheds would be dewatered from the beginning of the storm at the full 120 mgd capacity of the Griffith Pumping Station.


LEGEND
EXISTING SEWERS
NEW SEWERS
CONTROL STRUCTURE
JUNCTION STRUCTURE
NEW WATER MAIN
CANDLESTICK TUNNEL 4'-0" x 6'-6"
BAYSHORE FREEWAY
BLANKEN AVE
LATHROP AVE
TOCOLOMA AVE
VISITACION AVE
SUNNYDALE
SUNNYDALE TRUNK SEWER
78" ∅
48" ∅
NEW SUNNYDALE OUTFALL
PROPOSED RELOCATION OF 36"∅ BY OTHERS
30" ∅
60" ∅
42" ∅
36" ∅
TO BE ABANDONED
2'-6"x3'-9"
66" ∅
36" ∅
12" WATER MAIN
48" FM
PUMP STATION
20'W C/S SEWER
S.F. COUNTY LINE
SUNNYDALE

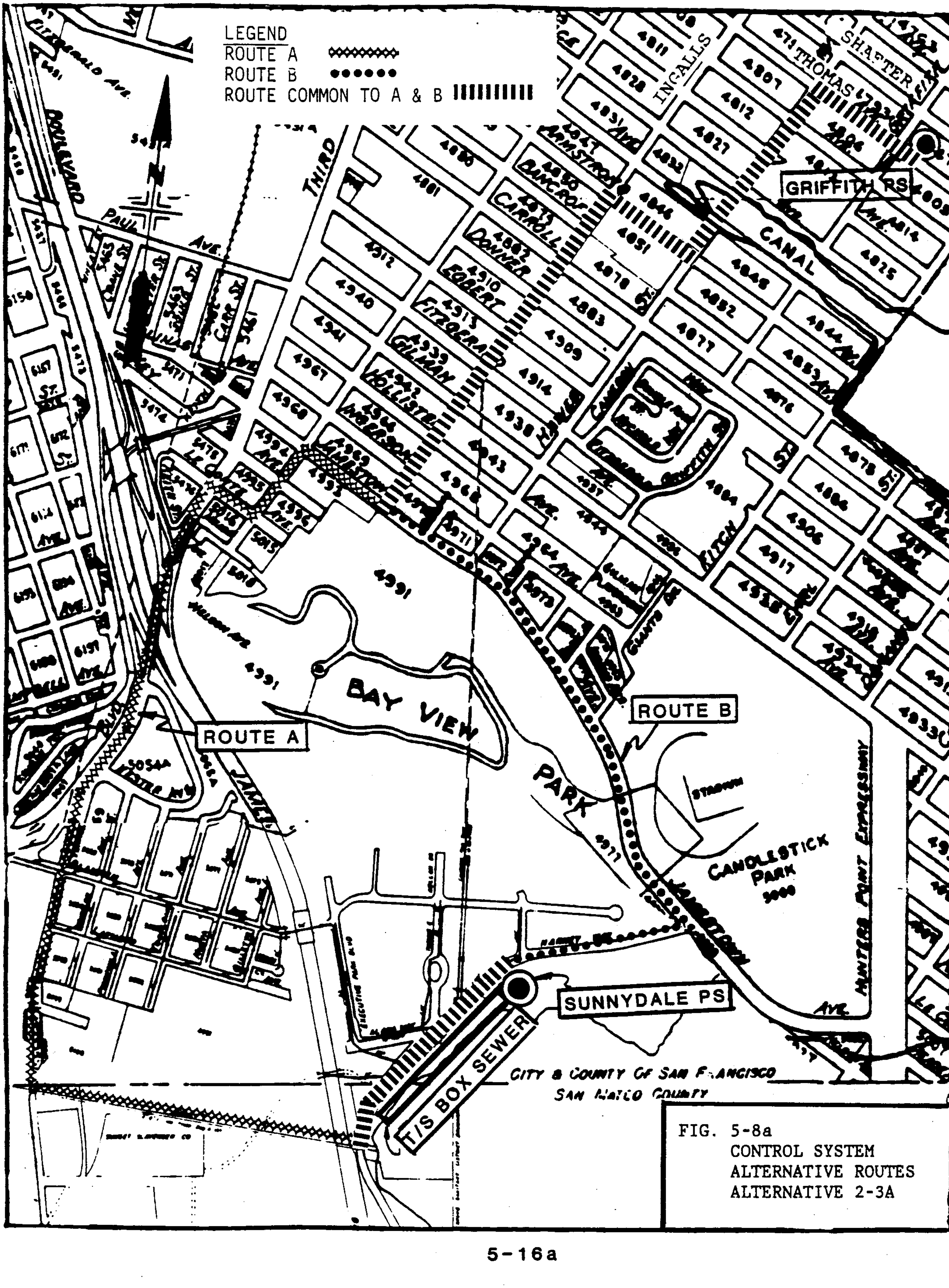


FIG. 5-8a
CONTROL SYSTEM
ALTERNATIVE ROUTES
ALTERNATIVE 2-3A

Table 5-3 Major Elements, Alternate 2-3A

Element	Location	Dimension	Capacity	Length, Feet
Transport/Storage	Alongside Harney	1350' x 20' x 30'	5.7 mil gal.	
Pumping Station		60'x 40' x 65'	50 mgd	
Interceptor	Easement	66"Ø		150
	Harney	66"Ø		50
	Alongside Harney	60"Ø		1280
Force Main	Harney	48"Ø		100
Structures		Control Structure (or Weir Structure)		3 EA
		Junction Structure		1 EA
Control System	(1)	(1)		11,500

(1)As per Fig. 5-8a, Route B

Fiberoptics inside 4"Ø PVC = 11,500 ft.
4"Ø PVC = 7,500 ft.)
4"Ø PVC (by others) = 4,000 ft.) Total 11,500 ft.

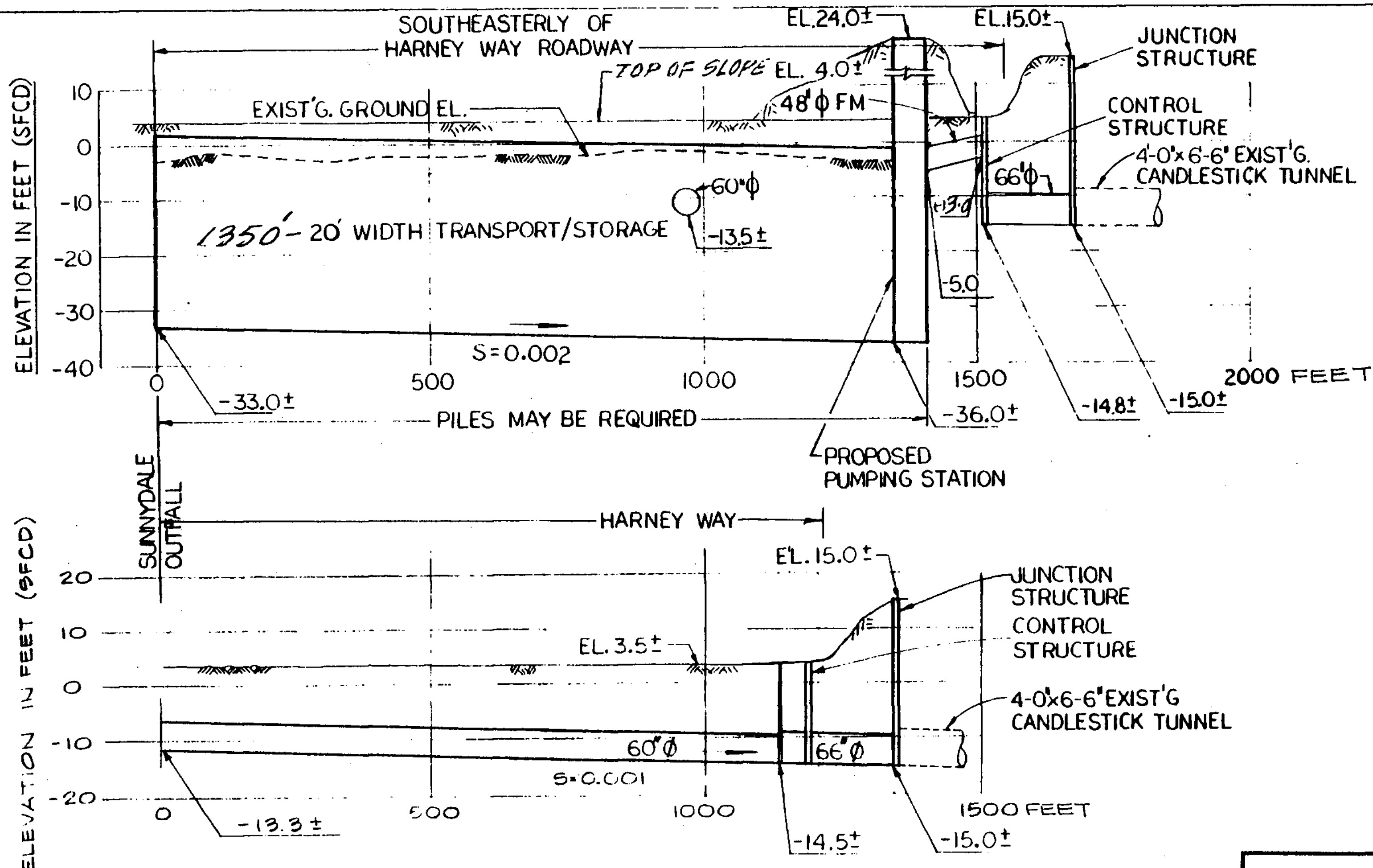


FIG. 5-9 ALTERNATIVE 2-3A PROFILE

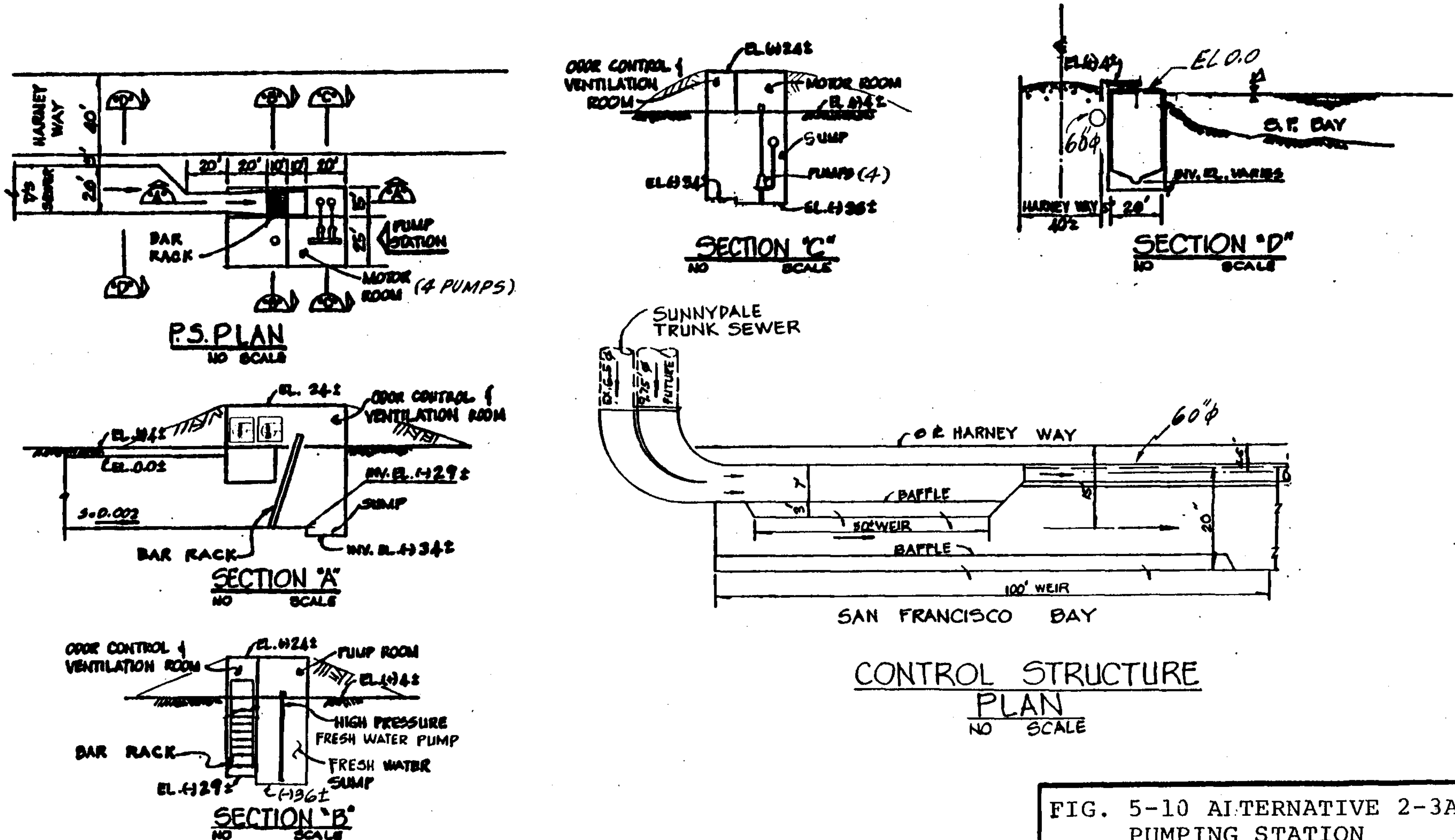
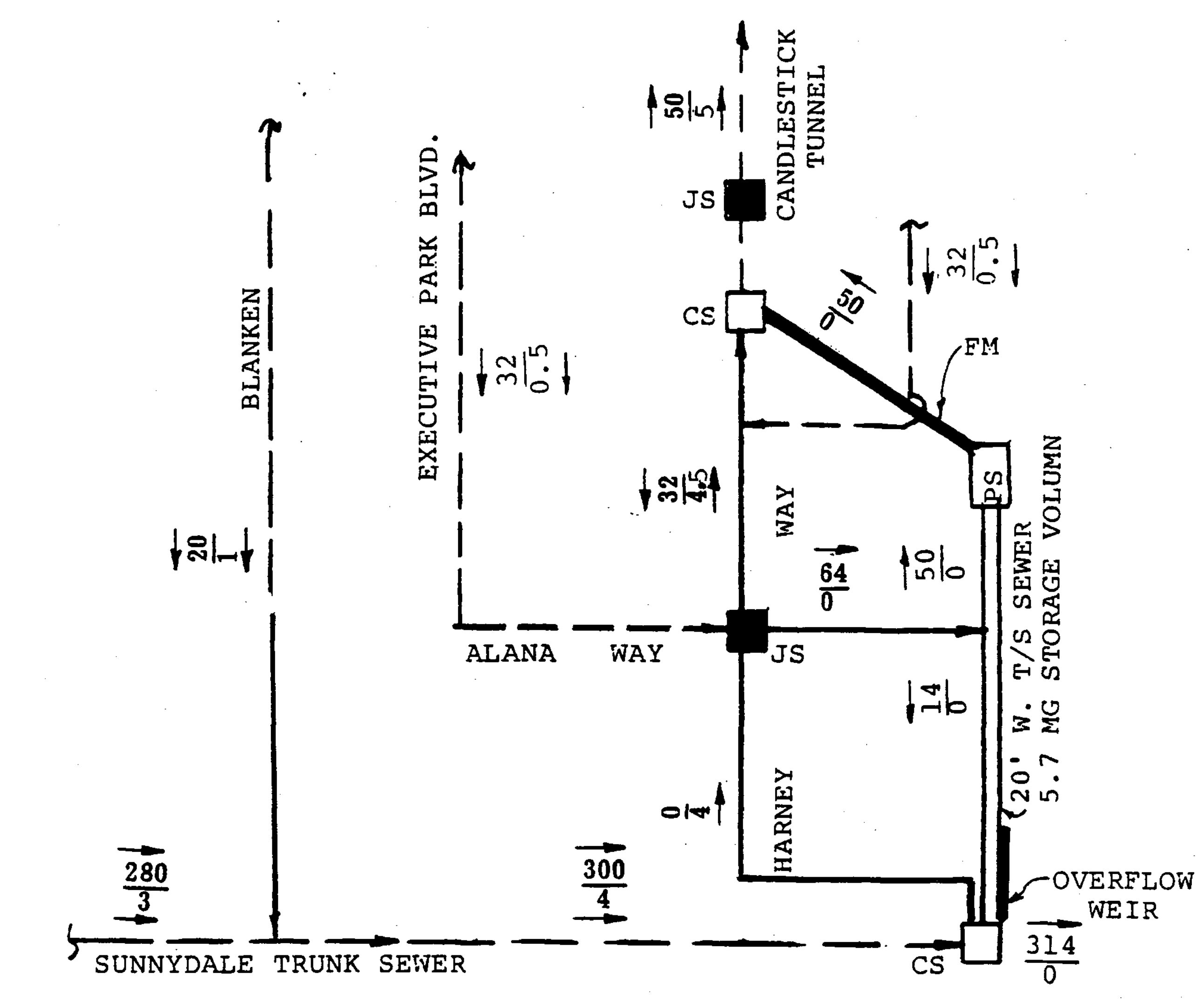


FIG. 5-10 ALTERNATIVE 2-3A
PUMPING STATION
PLANS AND SECTIONS



LEGEND

■	JS	JUNCTION STRUCTURE
□	CS	CONTROL STRUCTURE
— — —		EXISTING SEWER
———		PROPOSED SEWER
FM		PROPOSED FORCE MAIN
T/S		PROPOSED T/S SEWER
	PS	PUMP STATION
280		WET WEATHER FLOW, MGD (5-YR. STORM)
3		AVE. DRY WEATHER FLOW, MGD

NOTE SCHEMATIC SHOWS WW FLOW QUANTITIES AND DIRECTIONS AFTER STORAGE VOLUME IS FULL

FIG.5-11
SCHEMATIC FLOW DIAGRAM
ALTERNATIVE 2-3A

Alternative 2-8

Major elements of Alternative 2-8 shown on Figure 5-20c and identified in Table 5-3a. Profiles and details for Alternative 2-8 are shown on Figures 5-14 and 5-15 and a schematic flow diagram is presented on Figure 5-16. The control system routes are shown on Figure 5-13 of which Route B was selected due to its shorter distance. Dry weather would pass through the existing and/or new interceptors to the Candlestick tunnel and into the Yosemite Basin. The number of overflows in the Sunnydale area would be reduced by an off-line storage of wet weather flows in a transport/storage sewer.

During wet weather, storm flows which do not exceed the capacity of Candlestick Tunnel will gravitate to the Yosemite-Fitch Facility (Y-F). The gravity flow capacity of the Candlestick Tunnel is 60 mgd when the water level in Y-F is below -18 feet and decreases as the Y-F water level continues to rise above -18 feet. When the Sunnydale storm runoff exceeds the 60 mgd capacity of the Candlestick Tunnel, the excess flow would go into storage in the T/S sewer by way of a control structure on the Sunnydale Trunk Sewer. The dewatering of the stored flows by the pumping station at a rate of 50 mgd would begin as soon as the water level in the Sunnydale T/S sewer is high enough to activate the pumps. The pumped flow would be discharged to the control structure in Harney Way via a proposed 48" diameter force main. From the control structure, the flow gravitates to the tunnel portal via a

66" diameter gravity main. As a result of hydrostatic pressure from the force main discharge and the rising water level in Y-F, the flap gate in the control structure would close and all the Sunnydale runoff will be diverted into the T/S sewer. When the gate closes, flows from the Little Hollywood and Executive Park are would be transported to the T/S sewer via a 60" diameter sewer. When the T/S sewer fills, the excess flow would discharge under a baffle and over a weir. The control structure at the existing outfall would discharge the excess flows into the Bay.

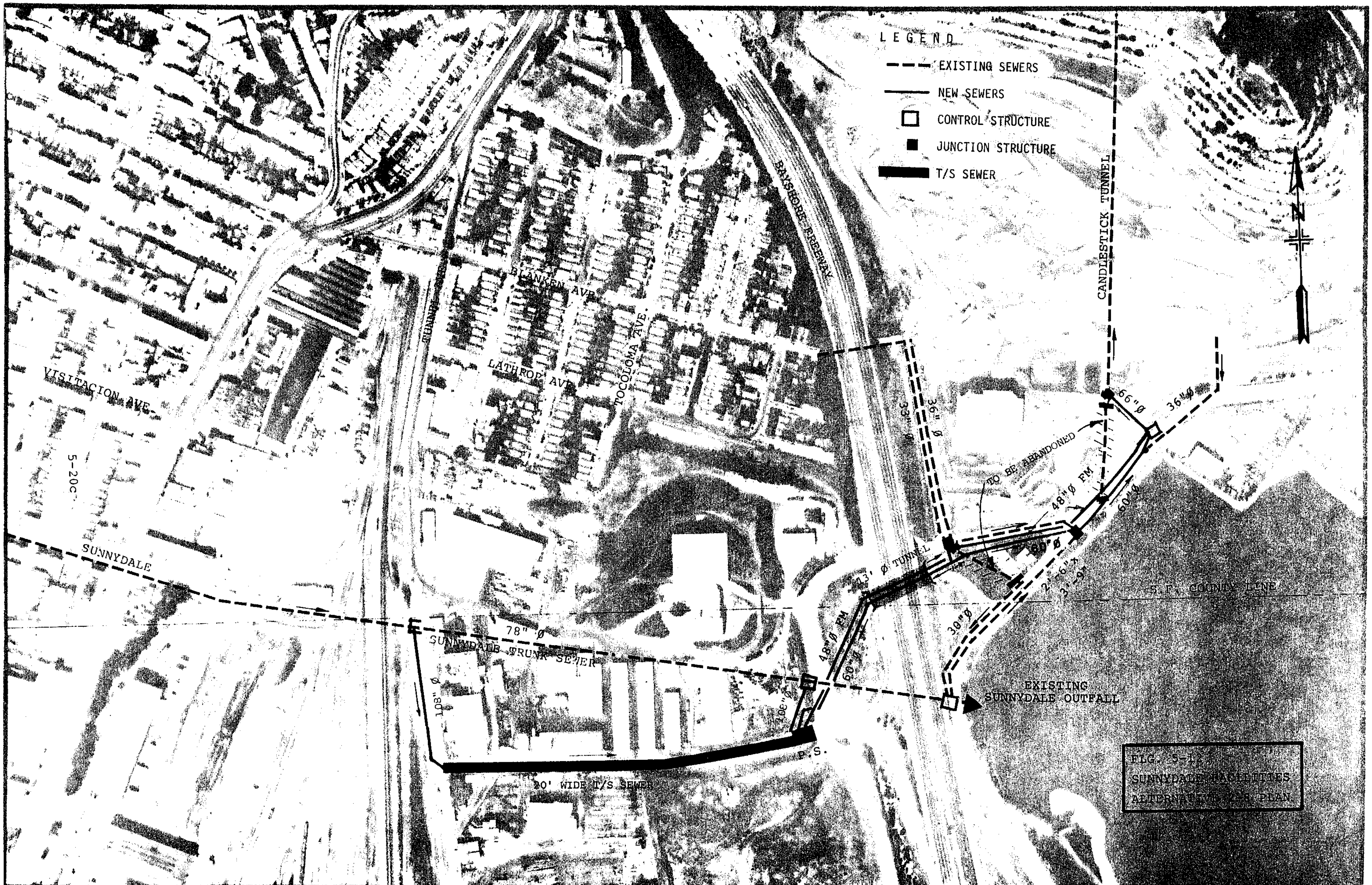


FIG. 5-12
SUNNYDALE FACILITIES
ALTERNATIVE 2-3 PLAN

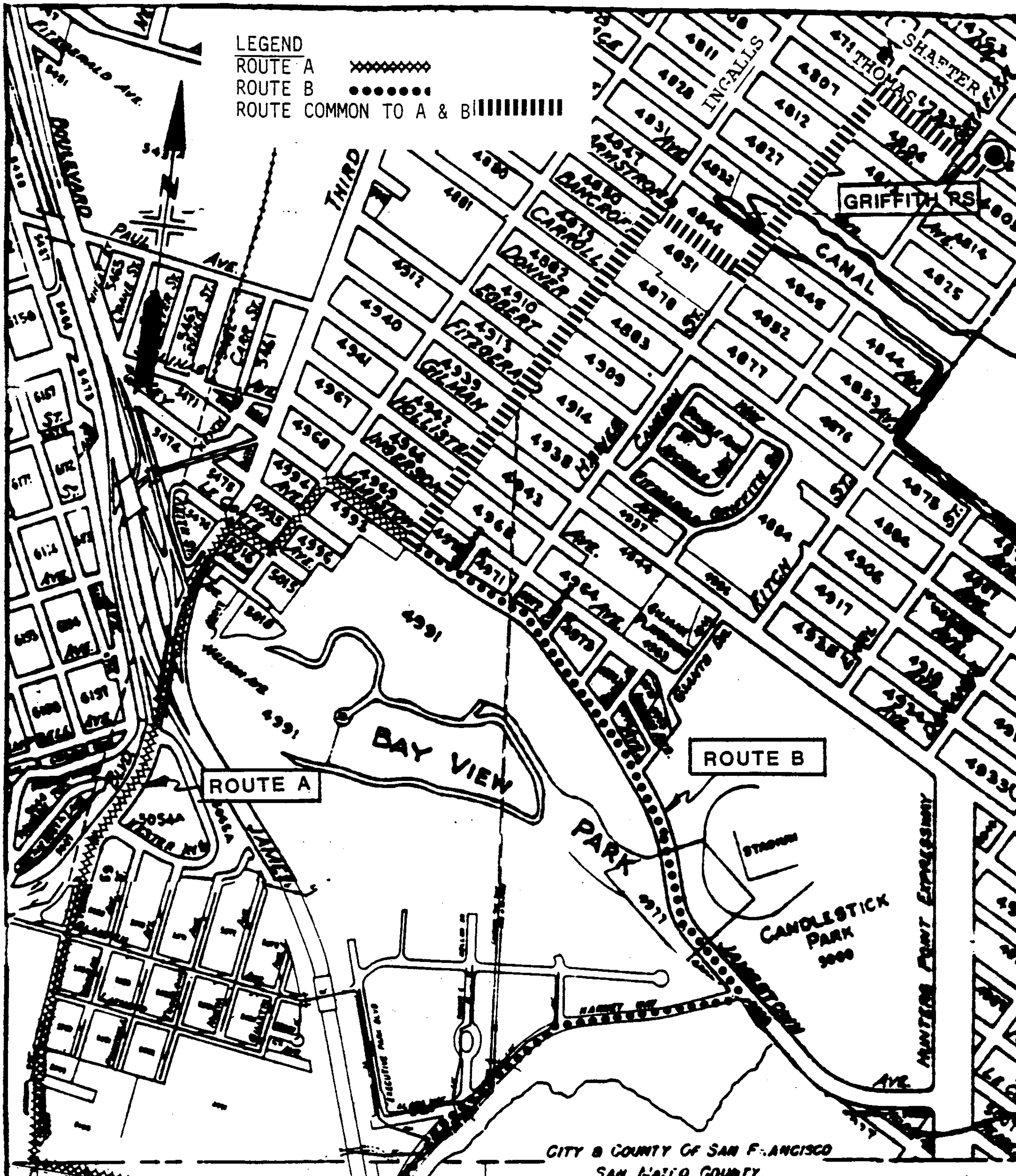


FIG. 5-13
CONTROL SYSTEM
ALTERNATIVE ROUTES
ALTERNATIVE 2-8

Table 5-3a Major Elements, Alternate 2-8

Element	Location	Dimension	Capacity	Length, Feet
Transport/Storage	Beatty Road	1350' x 20' x 30'	5.7 mil gal.	
Pumping Station		60'x 40' x 45'	50 mgd	
Tunnel	Easement	13'Ø		200
Interceptor	Tunnel Ave.	108"Ø		550
	Easement	108"Ø		200
	Easement	66"Ø		200
	Easement	60"Ø		1000
	Harney Way	60"Ø		450
Force Main	Easement	48"Ø		930
	Alana Way	48"Ø		450
	Alana Way	36"Ø (by others)		450
	Harney Way	48"Ø		450
Structures		Control Structure (or Weir Structure)		4 EA
		Junction Structure		3 EA
Control System	(1)	(1)		12,700

(1)As per Fig. 5-13, Route B

Fiberoptics inside 4"Ø PVC = 12,700 ft.
4"Ø PVC = 8,700 ft.)
4"Ø PVC)
(by others) = 4,000 ft.) Total 12,700 ft.

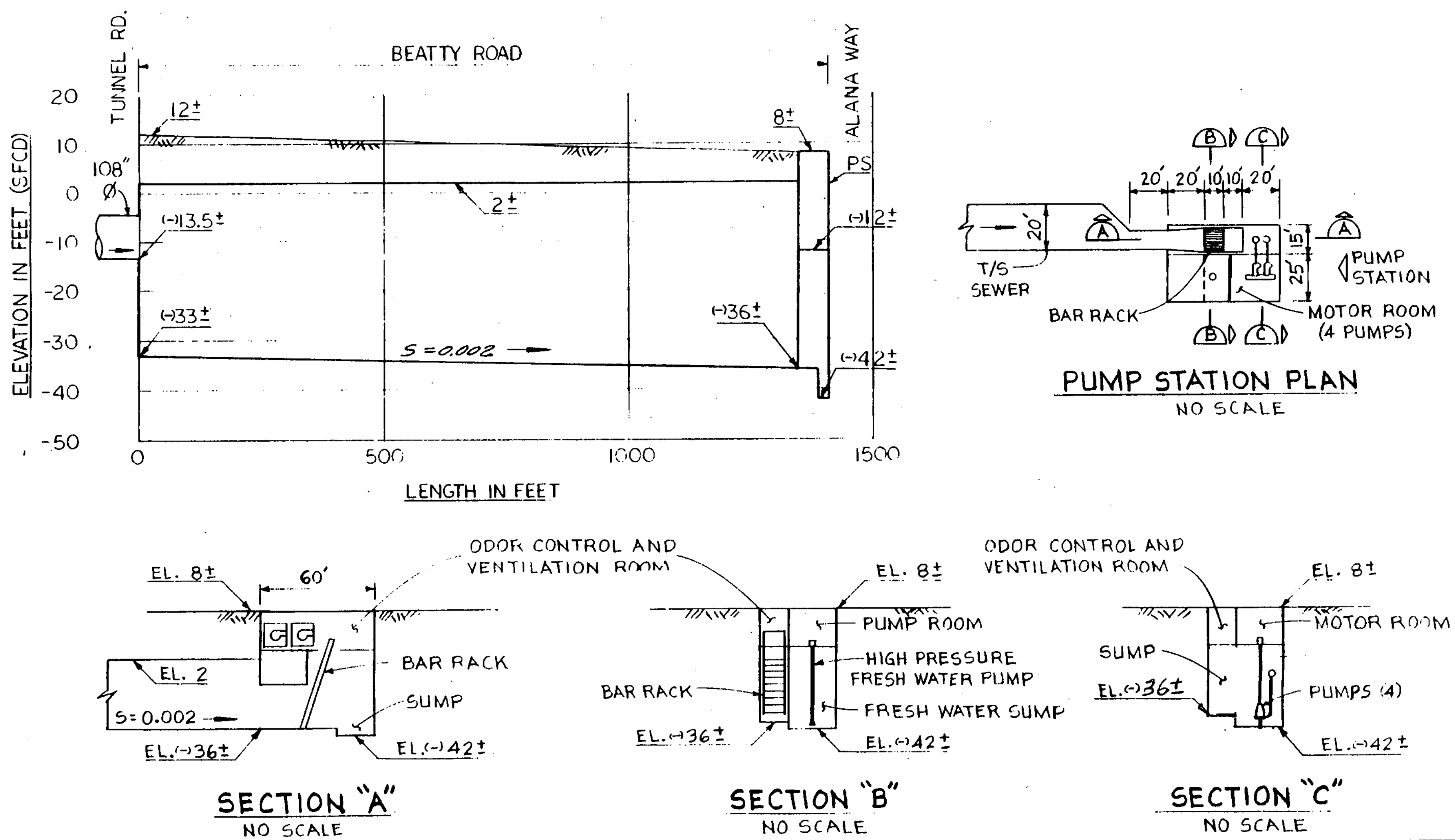


FIG. 5-14
SUNNYDALE FACILITIES
ALTERNATIVE 2-8
PROFILE & SECTIONS

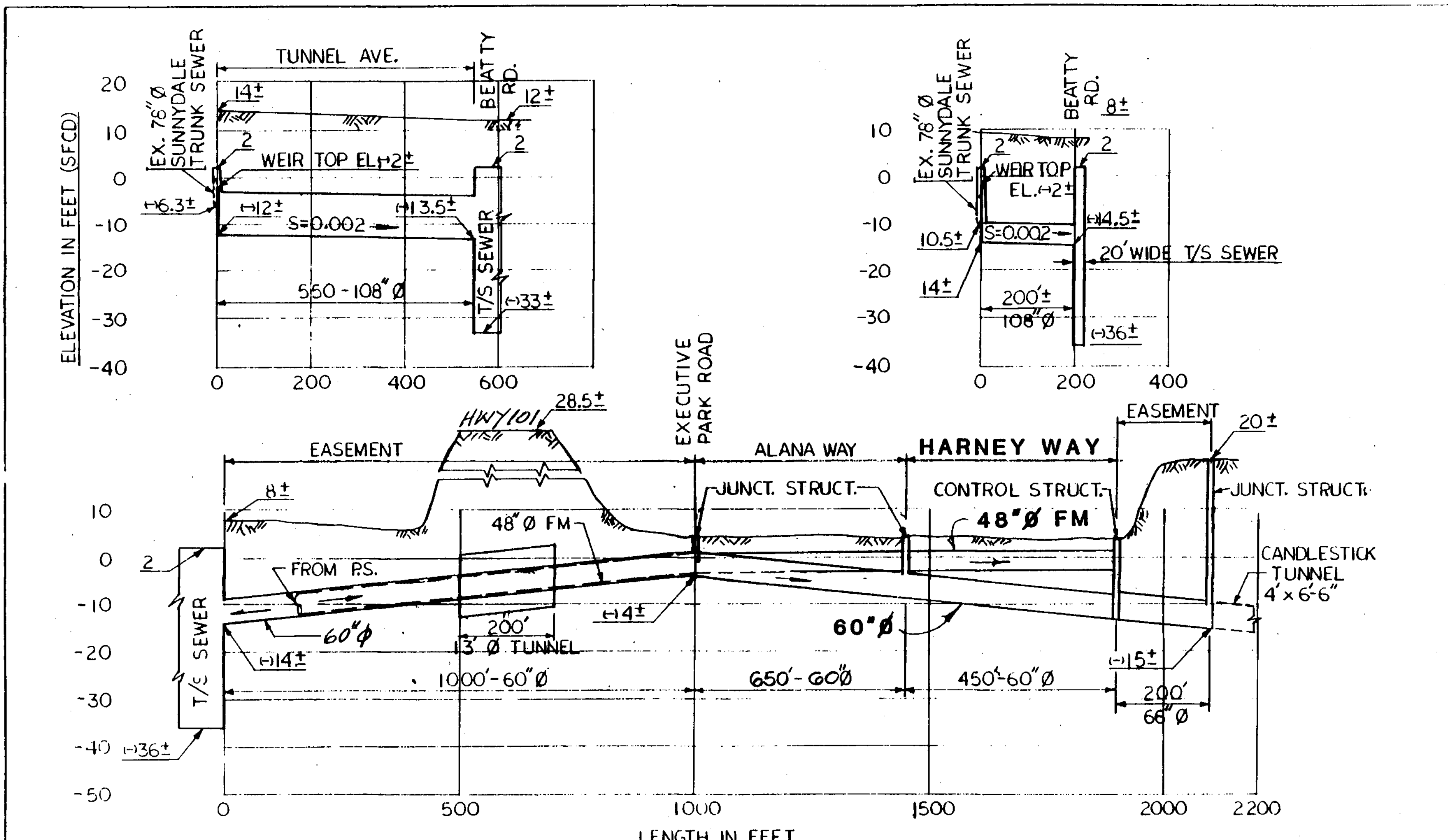
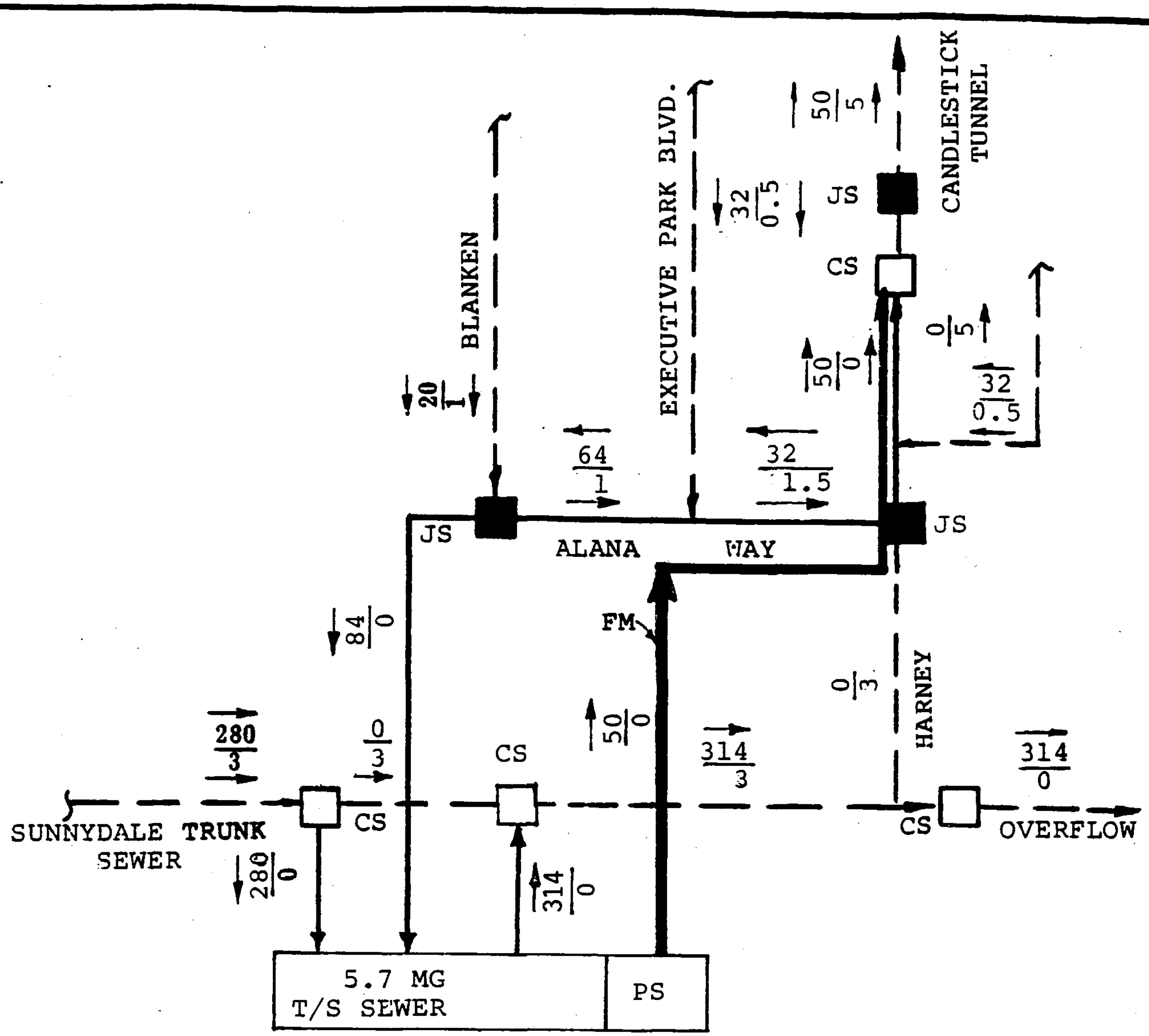


FIG. 5-15
SUNNYDALE FACILITIES
ALTERNATIVE 2-8
PROFILES



LEGEND

■	JS	JUNCTION STRUCTURE
□	CS	CONTROL STRUCTURE
– – –		EXISTING SEWER
———		PROPOSED SEWER
FM		PROPOSED FORCE MAIN
	PS	PUMP STATION
280		WET WEATHER FLOW, MGD (5-YR. STORM)
3		AVE. DRY WEATHER FLOW, MGD

NOTE SCHEMATIC SHOWS WW FLOW QUANTITIES AND DIRECTIONS AFTER STORAGE VOLUME IS FULL

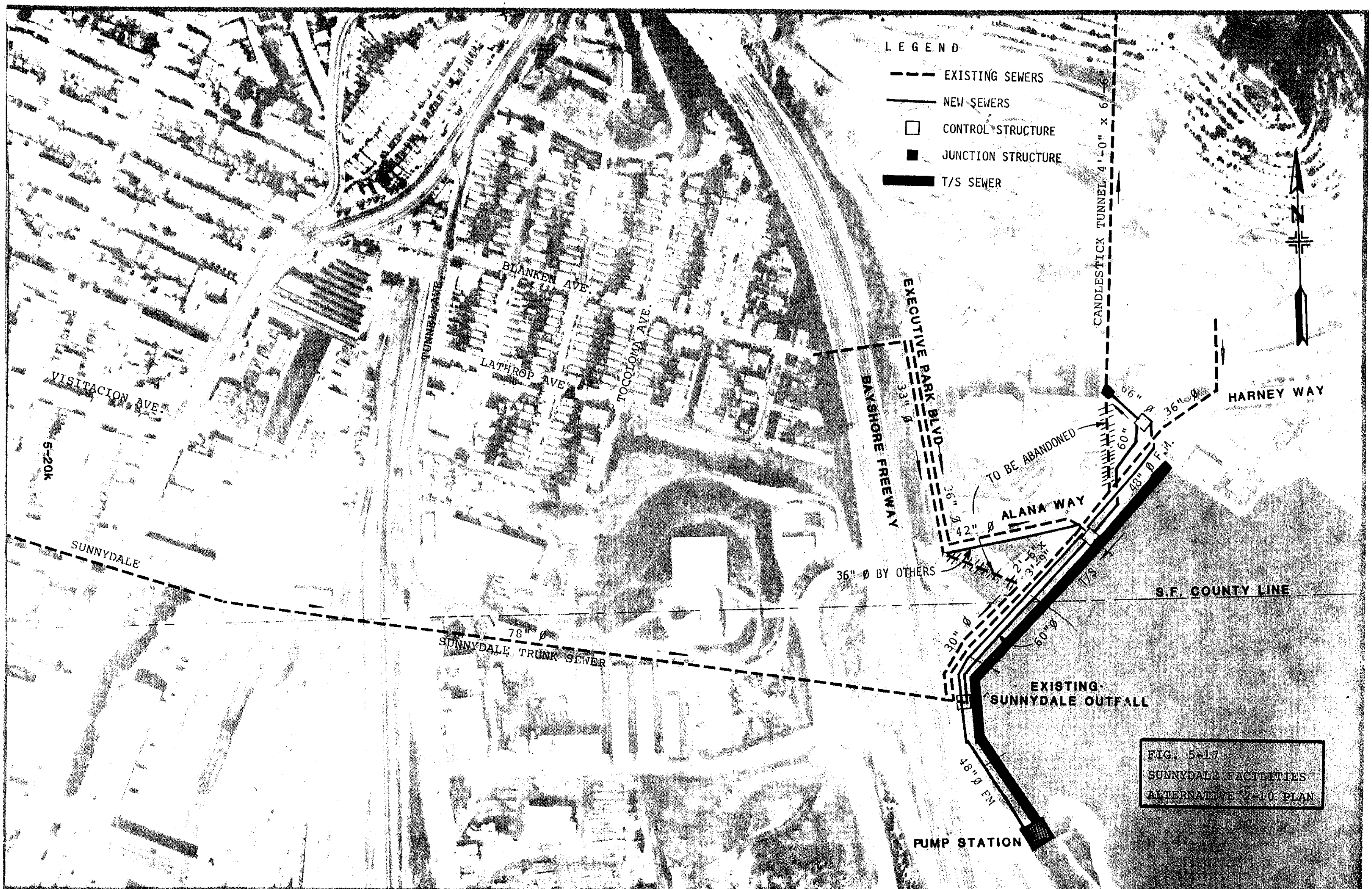
FIG 5-16
SCHEMATIC FLOW DIAGRAM
ALTERNATIVE 2- 8

Alternative 2-10

Major elements of Alternative 2-10 are shown on Figure 5-17 and identified in Table 5-3b. Profiles and details for Alternative 2-10 are shown on Figures 5-19 and 5-20 and a schematic flow diagram is presented on Figure 5-21. The control system routes are shown on Figure 5-18 of which Route B was selected due to its shorter distance. Dry weather flows would pass through the existing and/or new interceptors to the Candlestick tunnel and then to the Y-F basin. The number of overflows in the Sunnydale area would be reduced by the storage of wet weather flows in a transport-storage sewer.

During wet weather, flow would be initially transported by gravity throug the existing interceptor and new 60" and 66" diameter sewers to the Candlestick tunnel. These storm flows which do not exceed the capacity of Candlestick tunnel will gravitate to the Yosemite-Fitch Facility (Y-F). The gravity flow capacity of the Candlestick Tunnel is 60 mgd when the water level in Y-F is below -18 feet and decreases as the Y-F water level contiues to rise above -18 feet. When the Sunnydale storm runoff exceeds the 60 mgd capacity of the Candlestick Tunnel, the excess flow will díscharge into the T/S sewer by way of a control structure on the Sunndyale Trunk sewer. The dewatering of the stored flows by the pumping station at a rate of 50 mgd would begin as soon as the water level in the Sunnydale T/S sewer is high enough to activate the pumps. The pumped flow would be discharged to the control structure in Harney Way via a proposed 48" diameter force main. As a result of hydrostatic pressure from the force main discharge and the rising water level in Y-F, the flap gate in the control structure would close and all the Sunnydale runoff would be diverted into the reservoir. When the gate closes, the flows from the Sunnydale Trunk sewer, Little Hollywood and Executive Park area would overflow at a control structure in Harney Way into the transport-storage sewer. When the transport-storage sewer becomes full, excess flows would be screened by baffles to prevent release of floatables and then discharged into the Bay over a weir structure and new outfall structure located in the vicinity of the existing Sunnydale Outfall.

The Sunnydale wet weather flow transported through the Candlestick Tunnel would join with the Yosemite-Fitch runoff in the Yosemite Basin storage facility. The total flow from both watersheds would be dewatered from the beginning of the storm at the full 120 mgd capacity of the Griffith Pump Station.



LEGEND
EXISTING SEWERS
NEW SEWERS
CONTROL STRUCTURE
JUNCTION STRUCTURE
T/S SEWER
N
CANDLESTICK TUNNEL 4'-0" x 6'-6"
HARNEY WAY
66"
36" Ø
60"
48" Ø F.M.
TO BE ABANDONED
EXECUTIVE PARK BLVD
33" Ø
36" Ø
42" Ø
ALANA WAY
BAYSHORE FREEWAY
36" Ø BY OTHERS
T/S
S.F. COUNTY LINE
60" Ø
30" Ø
EXISTING SUNNYDALE OUTFALL
48" Ø FM
PUMP STATION
BLANKEN AVE.
LATHROP AVE.
TOCOLOMA AVE
TUNNEL AVE
VISITACION AVE.
SUNNYDALE
78" Ø
SUNNYDALE TRUNK SEWER
5-20k
FIG. 5-17
SUNNYDALE FACILITIES
ALTERNATIVE 2-10 PLAN

FIG. 5-18
CONTROL SYSTEM
ALTERNATIVE ROUTES
ALTERNATIVE 2-10

Table 5-3b Major Elements, Alternate 2-10

Element	Location	Dimension	Capacity	Length, Feet
Transport/Storage	Alongside Harney	1750' x 15' x 38'	5.7 mil gal.	
Pumping Station		60' x 40' x 48'	50 mgd	
Interceptor	Easement	66"Ø		150
	Harney	66"Ø		50
	Alongside Harney	60"Ø		1,280
Force Main	Harney	48"Ø		1,850
Structures		Control Structure (or Weir Structure)		3 EA
		Junction Structure		1 EA
Control System	(1)	(1)		11,800

(1)As per Fig. 5-8a, Route B

Fiberoptics inside 4"Ø PVC = 11,800 ft.
4"Ø PVC = 7,800 ft.)
4"Ø PVC)
(by others) = 4,000 ft.) Total 11,800 ft.

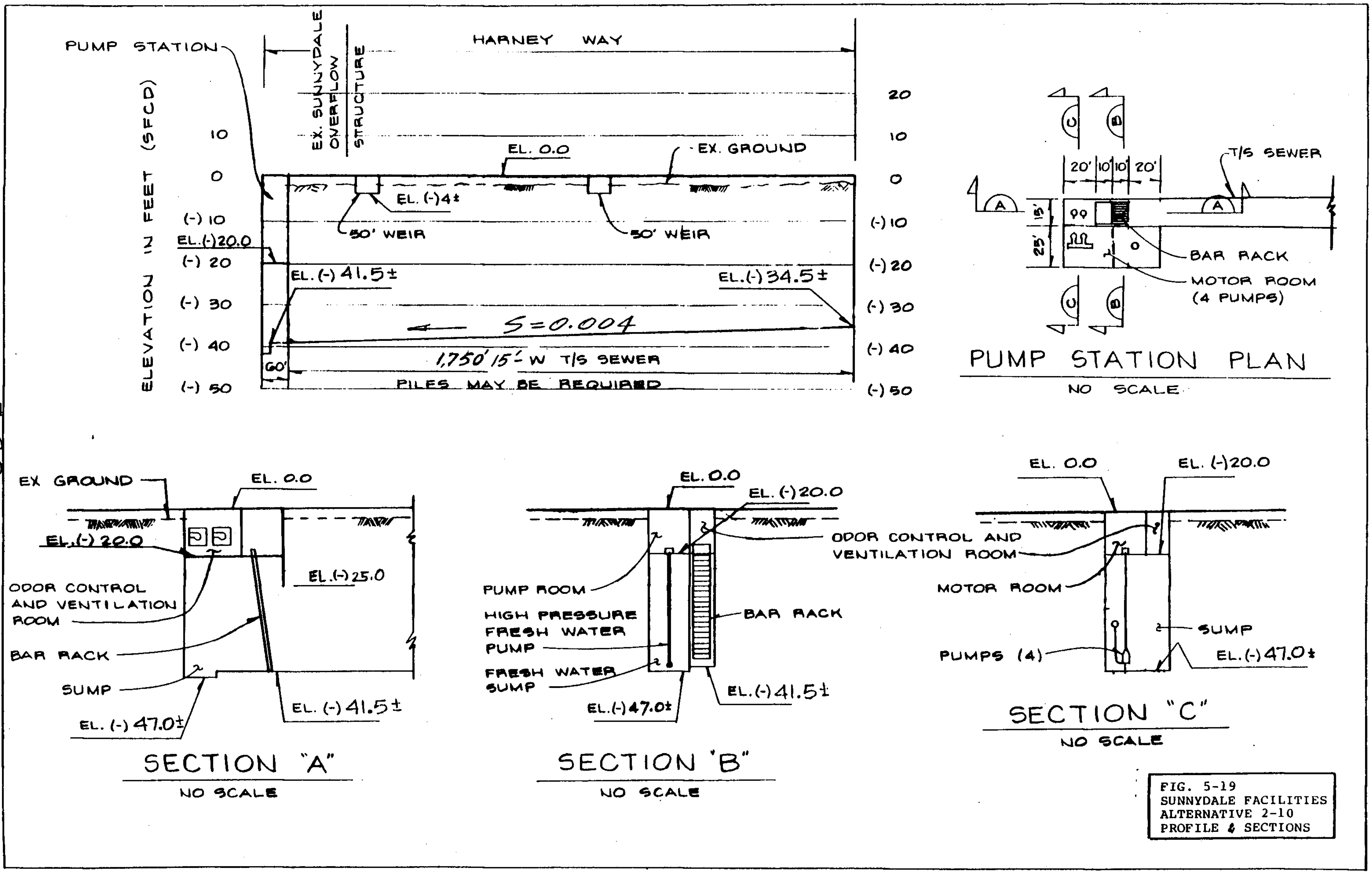


FIG. 5-19
SUNNYDALE FACILITIES
ALTERNATIVE 2-10
PROFILE & SECTIONS

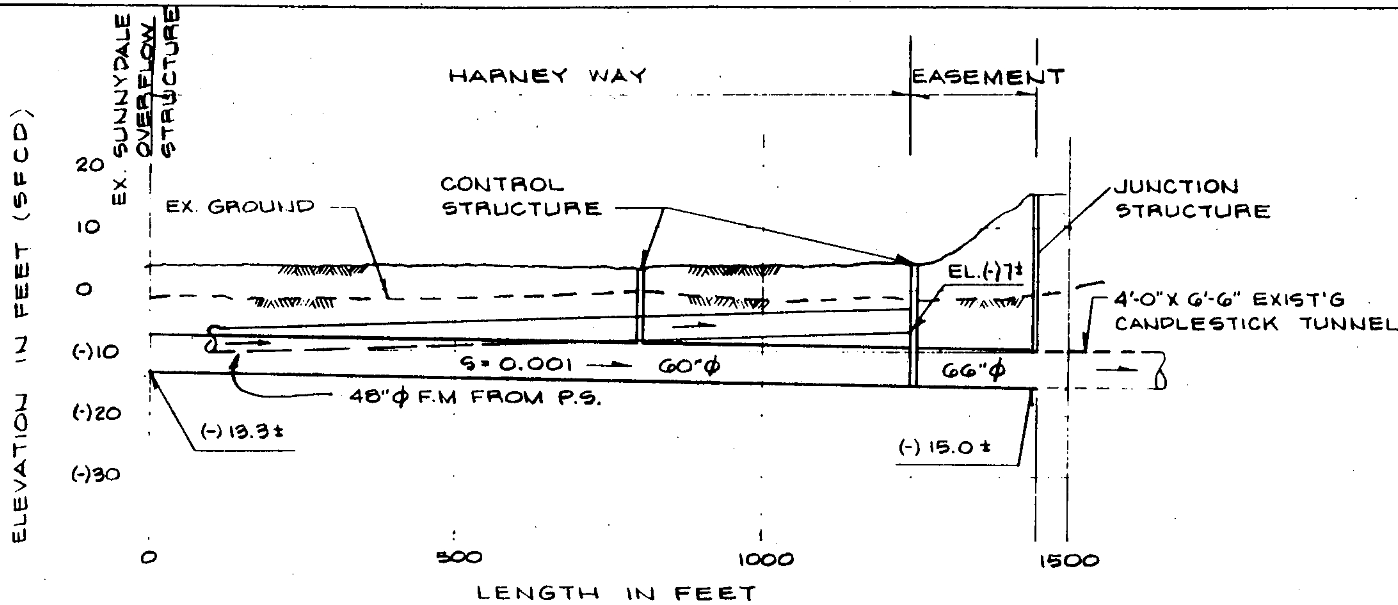
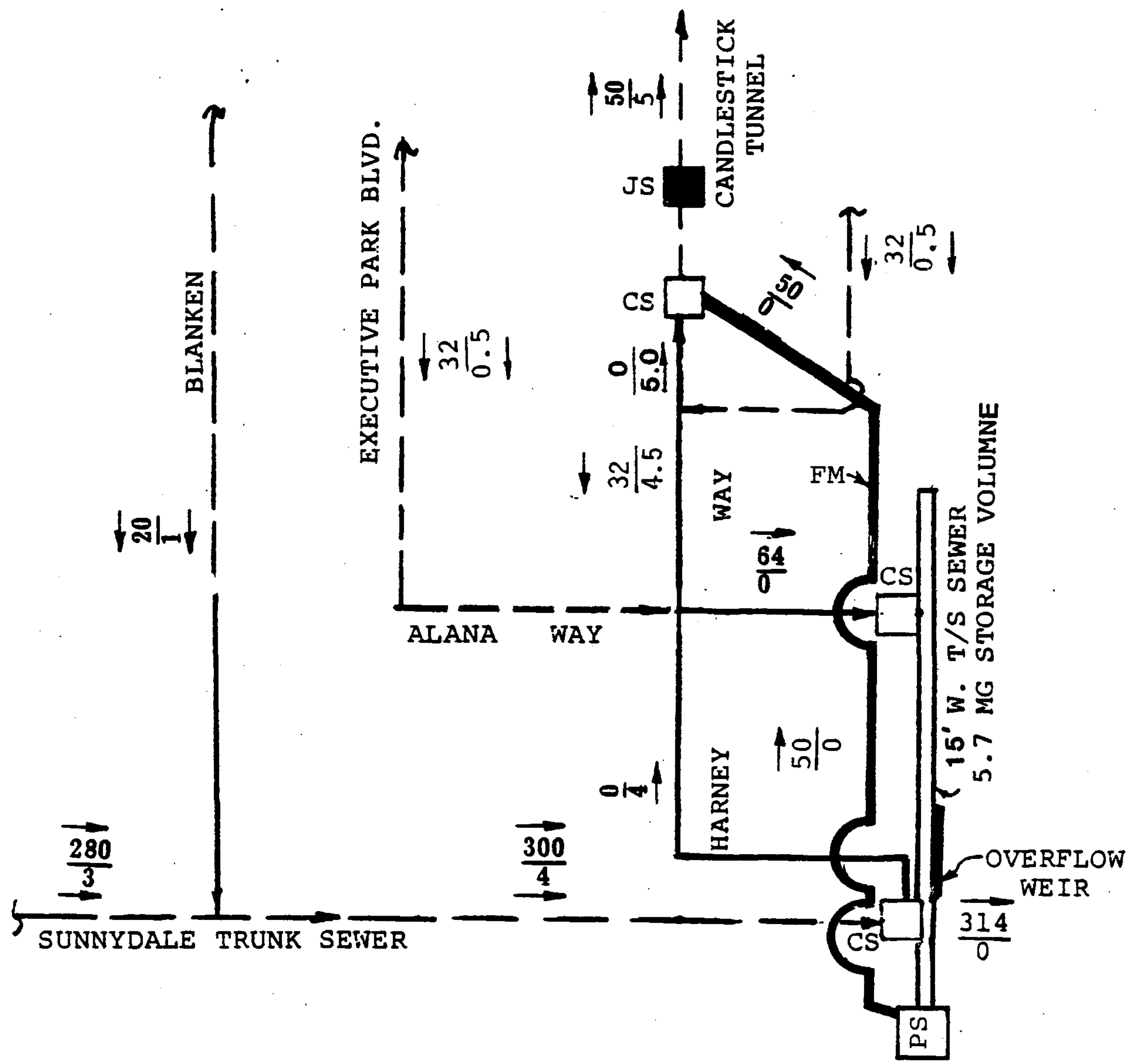


FIG. 5-20
SUNNYDALE FACILITIES
ALTERNATIVE 2-10
PROFILES



LEGEND

JS JUNCTION STRUCTURE
CS CONTROL STRUCTURE
FM
T/S
EXISTING SEWER
PROPOSED SEWER
PROPOSED FORCE MAIN
PROPOSED T/S SEWER
PS PUMP STATION
280
3
WET WEATHER FLOW, MGD (5-YR. STORM)
AVE. DRY WEATHER FLOW, MGD

NOTE SCHEMATIC SHOWS WW FLOW QUANTITIES AND DIRECTIONS AFTER STORAGE VOLUME IS FULL

FIG. 5-21
SCHEMATIC FLOW DIAGRAM
ALTERNATIVE 2-10

Cost Estimates:

The unescalated cost estimates at ENR 5044 for the final alternatives are presented in Tables 5-4 through 5-6b. Total present worths and equivalent annual costs are also shown. The cost estimates were developed using the methods as explained in Chapter 1 of the Southeast Bayside Project Report.

Construction Employment:

The amounts of direct construction labor and secondary employment that would be generated by implementing the Sunnydale alternatives are presented in Table 5-7. Secondary employment is that required to support the construction such as providing the basic construction materials (cement, pipe, etc.) or manufacturing pumps and other equipment items.

Solids Transport:

The transport-storage elements have been designed to maintain a minimum velocity of 2 feet per second under normal operating conditions in order to keep solids in suspension. However, velocities in large transport-storage facilities will decrease below 2 feet per second as storage increases in relation to the withdrawal rate. During such times, solids will settle. These solids must be removed from the facilities in order to prevent odors. Several methods of removing settled solids have been evaluated including manual cleaning with shovels and mechanical equipment, manual flushing with fire hoses, flushing using gates in the transport-storage elements to sequentially flush downstream sections with stored water and flushing with an installed system of pipes and nozzles.

Manual cleaning with shovels and mechanical equipment is the most labor intensive and time consuming. Manual flushing with fire hoses will be considered during the design of the system as it appears to be the most cost effective solution.

Table 5-4 Estimated Cost of Sunnydale Transport/Storage Facility, Alternative 2-1

Cost Item	Cost (Million Dollars)	
	Present	Ultimate
Structural	16.12	16.12
Mechanical and Electrical	1.70	1.78
Site Preparation	0.43	0.43
Total Construction	18.25	18.33
Land	4.27	4.27
Total Capital	22.52	22.60
Annual Energy	0.01	0.01
Annual Labor and Materials	0.17	0.17
Total Annual O&M	0.18	0.18
Present Worth of O&M	1.89	1.89
2nd Compartment in Yosemite/Fitch	0.99	0.99
Additional Storage in Yosemite/Fitch	7.12	7.12
Total Present Worth	32.52	32.60
Equivalent Annual Total Cost	3.10	3.11

Pumping Rate:

Present 50 mgd
Ultimate 60 mgd

Table 5-5 Estimated Cost of Sunnydale Transport/Storage Facility, Alternative 2-2B1

Cost Item	Cost (Million Dollars)	
	Present	Ultimate
Structural	18.18	18.18
Mechanical and Electrical	1.70	1.78
Site Preparation	0.39	0.39
Total Construction	20.27	20.35
Land	2.36	2.36
Total Capital	22.63	22.71
Annual Energy	0.01	0.01
Annual Labor and Materials	0.17	0.17
Total Annual O&M	0.18	0.18
Present Worth of O&M	1.89	1.89
Total Present Worth	24.52	24.60
Equivalent Annual Total Cost	2.34	2.34

Pumping Rate:

Present 50 mgd
Ultimate 60 mgd

Table 5-6 Estimated Cost of Sunnydale Transport/Storage Facility, Alternative 2-3A

Cost Item	Cost (Million Dollars)	
	Present	Ultimate
Structural	15.55	15.55
Mechanical and Electrical	1.70	1.78
Total Construction	17.25	17.33
Land	0.35	0.35
Total Capital	17.60	17.68
Annual Energy	0.01	0.01
Annual Labor and Materials	0.17	0.17
Total Annual O&M	0.18	0.18
Present Worth of O&M	1.89	1.89
Total Present Worth	19.49	19.57
Equivalent Annual Total Cost	1.86	1.87

Pumping Rate:

Present 50 mgd
Ultimate 60 mgd

Table 5-6a Estimated Cost of Sunnydale Transport/Storage Facility, Alternative 2-8

Cost Item	Cost (Million Dollars)	
	Present	Ultimate
Structural	20.41	20.41
Mechanical and Electrical	1.70	1.78
Site Preparation	0.19	0.19
Total Construction	22.30	22.38
Land	2.35	2.35
Total Capital	22.65	22.73
Annual Energy	0.01	0.01
Annual Labor and Materials	0.17	0.17
Total Annual O&M	0.18	0.18
Present Worth of O&M	1.89	1.89
Total Present Worth	24.54	24.62
Equivalent Annual Total Cost	2.33	2.34

Pumping Rate:

Present 50 mgd
Ultimate 60 mgd

Table 5-6b Estimated Cost of Sunnydale Transport/Storage Facility, Alternative 2-10

Cost Item	Cost (Million Dollars)	
	Present	Ultimate
Structural	17.91	17.91
Mechanical and Electrical	1.70	1.78
Total Construction	19.61	19.69
Land	0.41	0.41
Total Capital	20.02	20.10
Annual Energy	0.01	0.01
Annual Labor and Materials	0.17	0.17
Total Annual O&M	0.18	0.18
Present Worth of O&M	1.89	1.89
Total Present Worth	21.91	21.99
Total Cost	2.09	2.10

Pumping Rate:

Present 50 mgd
Ultimate 60 mgd

Table 5-7 Construction Employment for Sunnydale Transport/Storage Alternatives

Alternative	Direct Construction Employment, Worker-Years	Secondary Employment, Worker-Years
2-1	149	406
2-2B1	113	306
2-3A	90	243
2-8	113	306
2-10	101	273

It does not require the expensive installation of pipes and nozzles or gates, however, it is labor intensive. This system would require a flow rate of 200 gallons per minute (gpm) at a discharge pressure of 75 pounds per square inch gage (psig). The hose bibs would be located 200 feet apart and would require the use of 100 foot fire hoses. It is estimated that it would take approximately 30 minutes to clean a 200 foot section using 6,000 gallons of water. Flushing with a system of pipes with nozzles near the bottom of the transport storage structure may be the most practical solution because it doesn't require much manual labor; however, it is the most expensive system to install. This system would require a flow rate of 30 gpm per foot of length of the structure at a discharge pressure of 150 psig. If a 100 foot length were flushed at a time, 3,000 gpm would be required. Four potential sources of flushing water include the City's domestic water system, treated effluent from the southeast WPCP, groundwater from wells, and decanted raw wastewater from the transport-storage facilities themselves. Bay water is unsuitable because the salt water would corrode the pumps, pipes, and nozzles and attack the concrete structures. In addition, the use of saltwater might upset the biological treatment processes at the Southeast WPCP. This system of flushing the transport-storage system is discussed in greater detail in Section 7 of this report.

Utilization of Scarce Resources:

The two significant scarce resources considered in the analysis of the Sunnydale alternatives are land and energy. Sites utilized by the final alternatives during construction are shown on Figure 4-5 and were described previously. Three of the sites are on publicly held land which can be returned to existing use following construction. The other two sites are on private land; and requirements for relocation of operations would result in the need for equivalent sites for the same land use elsewhere in the City. Energy requirements of the final alternatives are minimal. Energy requirements are presented in Table 5-8. The peak demands can be supplied by Pacific Gas and Electric Company (PG&E) through its existing system.

Table 5-8 Energy Requirements for Final Sunnydale Transport/Storage Alternatives (Present and Ultimate)

Alternative	Peak Demand, kw Sunnydale Facilities	Energy Use Million kwhr/yr	Residential Equivalent[a]
2-1	910	0.11	16.5
2-2B1	910	0.12	18.0
2-3A	910	0.11	16.5
2-8	910	0.11	16.5
2-10	910	0.11	16.5

[a] Residential equivalent is the number of Bay Area residence which would consume the same annual energy as the alternative, based on PG&E data showing single-family residential energy use in the Bay Area to be 6,600 kwhr per year without air conditioning.

Traffic Impacts and Soil Removal

There will be no long-term significant traffic problems associated with the final alternatives since the facilities are unmanned and traffic will be limited to periodic visits by maintenance personnel. During construction, however, significant traffic impacts may occur.

The Sunnydale Facilities are located in the predominantly industrial southeast quadrant of the City. The most significant impacts generated by the various alternatives would be traffic disruptions caused by construction of wide cast-in-place transport-storage structures. Mitigation strategies should include proper traffic diversion tactics and proper street signing and delineation tactics throughout the construction zones as described in the Traffic Impacts Analysis Report (Reference 10[a]).

In the Sunnydale area, construction activities on Harney and Alana Way would reduce street capacity which would be critical during game days at Candlestick Stadium. Alana Way construction would impede access to the new Executive Park office development and seriously disrupt traffic through the Alana Way underpass crossing the freeway. Flagmen shall be used to alleviate traffic disruption. The contract will be phased in front of Executive Park office to reduce difficulties of access.

[a] Refers to References in Appendix A of "Bayside Facilities Plan, Southeast Bayside Project Report, March 1982".

Spoils are the excess dirt and rock excavated during the construction of the facilities which cannot be replaced as backfill and must be hauled off by truck for disposal elsewhere. The volumes of loose spoils produced by the final alternatives are presented in Table 5-9. This material will be exported by dump trucks over specified local streets to the Candlestick interchange of U.S. 101 and to the disposal site. Restrictions may be placed on using specific streets for haul

Table 5-9 SUNNYDALE FACILITIES SPOILS

ALTERNATIVE	EXCAVATED VOL (C.Y.)	EXCAVATED VOL. +20% SWELL (C.Y.)
2-1	87,750	105,300
2-2B1	73,780	88,540
2-3A	56,250	67,500
2-8	92,900	111,500
2-10	60,000	72,000

routes. In order to avoid spilling dirt, trucks will not be overloaded. Speed limits will be enforced. Truck wheels will be hosed off as necessary due to muddy conditions before leaving the construction sites. Haul route recommendations specific to the apparent best alternative project are presented in Chapter 5 of the Bayside Report.

The traffic impacts of the Sunnydale alternatives are shown in Table 5-10. The impacts are primarily due to the volume of spoils truck traffic generated by the project during construction and the number of traffic lanes required for the trenches and contractor's work area during construction, which would restrict through traffic along the alignment of the Sunnydale facilities. Major impact is indicated when construction of facilities is required in or alongside the roadway. Minor impact is shown when the roadway may be used by the truck traffic for spoils removal or when construction occurs at an intersection of the street.

Community Disruption:

Construction of any alternative will create some community disruption primarily consisting of the traffic impacts previously described. The proposed facilities under all alternatives would affect Sunset/Scavenger, San Francisco Executive Park, the Candlestick Park

Stadium, and Candlestick Point State Recreation Area during the construction period. The CECO Corporation storage yard would have to be relocated under Alternative 2-1. If no suitable site can be found in the adjacent areas, relocation of the entire operation may be necessary.

Flexibility

All alternatives are flexible because the Sunnydale facilities would still be usable if the downstream facilities in Islais Creek are not constructed. In this case, since flow rates from Sunnydale would have to be reduced to match available

Table 5-10 Comparison of Traffic Impacts for Sunnydale Facilities Alternatives

STREET IMPACTED	ALTERNATIVE				
	2-1 (CECO)	2-2B1 (SCAVENGER)	2-3A (Bay)	2-8 (Beatty Road)	2-10 (Bay)
Harney Way	MAJOR	MAJOR	MAJOR	MINOR	MAJOR
Thomas E. Mellon	MINOR	MINOR	MINOR	MINOR	MINOR
Alana Way	MAJOR	MAJOR	MINOR	MAJOR	MINOR
Executive Park	MINOR	MINOR	MINOR	MINOR	MINOR
Freeway Ramp	MINOR	MINOR	MINOR	**MAJOR**	**MAJOR**
Tunnel **Ave**	MAJOR	NONE	NONE	MAJOR	NONE
Beatty Road	NONE	MINOR	NONE	MAJOR	NONE

MAJOR: Construction interference occurs in streets
MINOR: Intersection or local access impacts

treatment capacity at the Southeast WPCP, the pump-dependent alternatives, 2-2B1, 2-3A, 2-8 and 2-10 would provide the better flexibility. Overflows would be reduced below the present levels of approximately 40 per year, but not to the NPDES permit level of one overflow per year unless additionally storage were added. If the Islais Creek facilities are constructed and overflow requirements become more stringent in the future, these same four alternatives would provide the greater flexibility because the pumping rates can be increased from 50 mgd to 60 mgd. In the event the pumping rate has to be greater than 60 mgd to meet more stringent overflow requirements additional storage would have to be constructed either in the Yosemite-Fitch or Sunnydale area.

Reliability:

The reliability of all alternatives is dependent upon the performance of the pump stations. The wet weather pumps will be used about 40 times per year. It is estimated that each pump station might contain an average of four pumps and each pump might break down once every five years. From an analysis of the distribution of pumping rates, it is estimated that all four pumps will be needed only about half the time the pump station is operating. Therefore, the chances of a pump failing when it is needed is one out of 100 pumping events (four pumps, each having one chance out of 40 events per year x 5 years 0.5 used factor = four out of 400 events or one out of 100 events). Such a failure record would have a negligible increase on the annual average number of overflows. Therefore, the reliability of the alternatives against equipment breakdown is very high.

Power failures which occurred approximately 10 times in the past year are a more likely occurrence than equipment breakdown. A power failure during wet weather would cause an overflow if the storage is full.

Chances of an operator error would be minimal with the proposed supervisory control system and alarms and equipment interlocks.

Facilities will be designed to applicable seismic standards. Force mains would be shut down in the event of a large earthquake to prevent uncontrolled discharge of raw wastewater from a broken pipe.

Implementability

All alternatives are relatively easy to implement. Sites S-1 and S-2 are privately owned. An easement is required from Caltrans for the crossing of U.S. Highway 101 at or near Alana Way under Alternative 2-1, 2-2B1, and Alternative 2-8, Alternatives 2-3A and 2-10 require easements from Candlestick Point State Recreation Area. All alternatives require revised easement from Campeau Corporation for the new pipe alignment through their property to the existing tunnel portal. Any of the final alternatives can be constructed within 24 months which is within the 35-month construction period stated in the City's Master Plan Schedule. Agency permits or approvals are required to implement any of the final alternatives; these requirements are lsited in Table 5-11.

Compatibility with Adjacent Land Use

Impacts of the final alternatives on adjacent land use will be either short-or long-term. Short-term land use impacts will result from open-cut construction activities. Long-term land use impacts will result from construction of pump stations and reservoirs on specific sites. Table 5-12 presents the potential long-term land use impacts resulting from construction at specific pump station or reservoir sites.

Bypass Analysis

Under all the alternatives, bypassing the Sunnydale facilities is possible since the existing Sunnydale trunk sewer would not be plugged and the control structure at the Sunnydale outfall structure where a weir is used as a control would not prevent overflow. In the event that gates are used for control, a power failure during bypassing could result in upstream flooding. In all Alternatives, bypasses of flows in excess of a 1-year storm could occur around the Sunnydale facilities through the existing Sunnydale trunk sewer and outfall or proposed control structures.

Tide Protection Analysis

The T-S facility in Alternatives 2-3A and 2-10 would be subject to tidal effects because it is located along the shoreline. Therefore, the control structure must be designed to prevent inflow of Bay waters which would corrode mechanical equipment and which would cause an upset of the secondary treatment process. This only requires that the overflow weir be set above tide level.

Table 5-11 Agencies Granting Permits or Approval Required for Sunnydale Alternatives

Agency	Alternative				
	2-1	2-2B1	2-3A	2-8	2-10
Bay Conservation and Development Commission	X	X	X	X	X
Caltrans	X	X		X	
State Department of Parks and Recreation			X		X
Corps of Engineers			X		X
San Francisco Planning Commission	X	X	X	X	X
San Francisco Art Commission	X	X	X		X
San Francisco Bureau of Building Inspection	X	X	X	X	X
City of Brisbane				X	X
Environmental Protection Agency	X	X	X	X	X
State Water Resources Control Board	X	X	X	X	X
Bay Area Air Quality Management District	X	X	X	X	X
Regional Water Quality Control Board	X	X	X	X	X
San Francisco Board of Supervisors	X	X	X	X	X
State Lands			X		X

Public Acceptability

Public acceptability of the final alternatives for the Sunnydale Facility will likely hinge on the short-term construction impacts of each alternative. Also during construction, there would be temporary disruptive visual sights during open-cut construction at the sties of the transport/storage or reservoir facilities, the pump stations, control structure, and pipelines.

Long-term visual effects are expected to be minimal since the facilities would either be buried, bermed or designed with small building envelopes which would be architecturally treated and landscaped.

The facilities included in the final alternatives are expected to operate very quietly for the duration of their service life. During construction, it is expected that noise and vibration would be generated by vehicles, pile drivers, excavation equipment, compressors, etc. This noise would be limited to the active working area which would move along the route of construction in the case of in-street facilities. It is anticipated that construction activities would be limited to no more than 12 hours per day.

Design criteria for all alternatives require that there be no odors emitted during operation of the facilities. During construction, localized odors may be emitted where there is excavation in bay mud. Dust would be created by construction equipment and exhaust fumes would be emitted from the equipment.

Table 5-12 Potential Land Use Impacts, Sunnydale Alternatives

Alternatives				
2-1	2-2B1	2-3A	2-8	2-10
o Relocation of CECO storage yard o Possible relocation of entire CECO operation	o Impact on operations and planning and development by Sunset/Scavenger Corp.	Interfere with State Park uses.	None	None

6. SUMMARY COMPARISON OF ALTERNATIVES

SUMMARY COMPARISON OF ALTERNATIVES

This section presents a comparison of the Sunnydale alternatives on the basis of cost, environmental, and socioeconomic factors. The comparison results in a recommendation of the apparent best alternative for the Sunnydale facilities.

Evaluation Procedure

The evaluation procedure used to compare the final alternatives for this Amendment consists of ranking each alternative against a set of evaluation factors similar to the Southeast Bayside Project Report. These factors consist of costs, energy consumption, land requirements, traffic impacts, flexibility, reliability, implementability, and public acceptability.

Recommendation of the apparent best alternative based on any one factor may lead to adoption of an unacceptable alternative. For example, the least expensive alternative may be environmentally unacceptable; likewise, the most environmentally sound alternative may be too expensive to implement. Therefore, the importance of each factor must be considered. This procedure involves the comparison of a series of trade-offs between the advantages and disadvantages of each alternative against those of the other alternatives. Thus, the selection of the apparent best alternative project is based on trade-off considerations which place the preferred alternative over those offering less advantages or greater disadvantages in a majority of the factors considered.

Comparison of Sunnydale Alternatives

Table 6-1 presents the ranking of the Sunnydale alternatives against the evaluation factors.

Table 6-1 Ranking of Sunnydale Transport-Storage Facility Alternatives

Evaluation Factor	Alternatives				
	2-1	2-2B1	2-3A	2-8	2-10
Present Worth Cost	5	4	1	3	2
Energy Consumption	1	3	2	2	2
Land Requirements	5	4	3	2	1
Traffic Impacts	3	3	1	4	1
Flexibility	2	1	1	1	1
Reliability	1	1	1	1	1
Implementability	3	3	2	2	1
Public Acceptability	5	4	2	3	1

NOTE: NO. 1 RANKING INDICATES BEST ALTERNATIVE FOR SPECIFIED FACTORS

Table 6-2 Estimated Cost Comparison of Sunnydale Transport-Storage Facility Alternatives

Alternative	Contract Cost	Land Cost	Total Capital Cost	Annual Operation & Maintenance Cost			Present Worth Of O&M	Additional Storage in Yosemite/ Fitch Cost	Total Present Worth	Equiv-alent Annual Cost	Rank
				Labor Mat'ls	Energy	Total					
2-1	18.25	4.27	22.52	0.17	0.01	0.18	1.89	8.11	32.52	3.10	5
2-2B1	20.27	2.36	22.63	0.17	0.01	0.18	1.89	0	24.52	2.34	4
2-3A	17.25	0.35	17.60	0.17	0.01	0.18	1.89	0	19.49	1.86	1
2-8	22.30	0.35	22.65	0.17	0.01	0.18	1.89	0	24.54	2.33	3
2-10	19.61	0.41	20.02	0.17	0.01	0.18	1.89	0	21.91	2.09	2

Cost in millions of dollars for 50 MGD pumping rate.

Cost

A comparison of the monetary costs for the alternatives, based on estimates developed in Section 5, is presented in Table 6-2. Federal guidelines require that the comparison be based on present worth or equivalent annual cost. The total present worth costs vary from a low of $19.50 million for Alternative 2-3A to a high of $32.52 million for Alternative 2-1.

Energy Consumption

Energy requirements for pumping vary from a low of 22,000 kilowatt hours (kwhr) per year for Alternative 2-1 to 37,000 kwhr per year for Alternatives 2-2B1, 2-3A, 2-8 and 2-10.

Land Requirements

Alternatives 2-1, 2-2B1 and 2-10 require the acquisition of private property. All alternatives would require a realignment of the existing easement around the proposed hotel in Campeau property for construction of a 66" diameter transport sewer and a junction structure at the tunnel portal. The proposed sites for the alternatives are shown on Figures 4-5. Alternatives 2-3A, 2-8 and 2-10 are ranked best under this factor because the required sites do not contain residential or commercial development, i.e., buildings or residences.

Traffic Impacts

Table 6-3 presents the rankings for the traffic impacts described in Section 5. The results are that Alternative 2-3A and 2-10 would offer the least traffic impact, while Alternative 2-8 would offer the most traffic impact primarily because the work is extended over more streets. Alternatives 2-1, 2-2B1 and 2-8 have the possibility of the most severe traffic impact in the event that the pipelines are constructed through the Alana Way underpass.

Flexibility

All alternatives are equally flexible from the viewpoint that the Sunnydale facilities would still be usable if the major downstream facilities in the Islais Creek are not constructed. However, Alternatives 2-2B1, 2-3A, 2-8 and 2-10 are more flexible because the rate of transporting wet weather flows out of the Sunnydale basin can be increased or decreased by adjusting the pumping capacity.

Reliability

Alternative 2-1 is slightly more reliable than the other alternatives in case of power failure because it relies primarily on gravity flow and only needs a lift station to dewater the reservoir.

An evaluation of reliability also includes consideration of the bypass and tide protection analyses. Bypassing would be possible through the existing Sunnydale trunk sewer during heavy storms under all alternatives. The pump station and transport/storage facility at low elevations in Alternatives 2-3A and 2-10 would be designed for protection against tidal effects so there would be little difference among the alternatives.

There would be little difference among the alternatives in the case of a major earthquake since most of the facilities under any alternative would be located below ground and would be relatively safe.

In ranking the alternatives for reliability, slight preference is given to the gravity flow alternative (2-1) because of its relative immunity to power outages.

Implementability

Alternative 2-3A and 2-10 would be easier to implement because Site S-8 is partially developed park property. Permit requirements are presented in Table 5-11. Alternatives 2-1 and 2-2B1 require the acquisition of private property and would be more difficult to implement. Alternative 2-8 requires acquisition of a City of Brisbane street. Additionally, Alternatives 2-1, 2-2B1 and 2-8 require tunneling or jacking under the freeway which concerns Caltrans because of the presence of boulders and the design of the freeway support structures; therefore, obtaining permits from this agency would be difficult. The other agency permits and approvals do not appear to be a problem.

Public Acceptability

Alternatives 2-3A and 2-10 would probably be the more acceptable to the public because (1) direct construction impacts are more concentrated and limited to Harney Way; (2) proper landscaping along the shoreline above the constructed transport-storage facility would improve it to sever as a trail for the State Park and improve the accessibility to the bay, as well as improve its visual attractiveness. However, State Parks has objected to placement of the pump station in the park which leads us to 2-10, as being the more acceptable.

Alternative 2-1 would probably be the least acceptable to the public due to its proximity to residential areas. Construction impacts are extended along Tunnel Avenue and Alana Way, as well as on Harney Way.

Alternatives 2-2B1 and 2-8 pose severe construction impacts on the operations of the scavenger transfer station.

Recommended Apparent Best Alternative

The ranking of the Alternatives (Tables 6-1) reveals that Alternative 2-10 is the apparent best alternative. It is likely to be the more publicly acceptable alternative because its location would be well removed from residences and community services, and because it presents the least impact to community traffic flow. This alternative would also be easier to implement since it would be located on a site without commercial or residential development; i.e., it would not cause possible business relocation or disruption to business operations as in Alternatives 2-1, 2-2B1 and 2-8.

Alternative 2-3A is less desirable than Alternative 2-10 because of State Parks resistance to the pump station location, which may make it impossible for the City to implement.

Alternative 2-2B1 is less desirable than Alternative 2-10. It would cost more on a present worth basis. Alternative 2-2B1 would require the acquisition of a portion of the privately owned Sunset/Scavenger Transfer Facility site, and would cause major disruption to their operations during construction.

Alternative 2-8 is also less desirable than Alternative 2-10. It would disrupt Sunset/Scavenger's operations because of the construction in Beatty Road, and presents the most disruptive traffic impacts to the community.

Alternative 2-1 is the least desirable alternative. It would be the most expensive alternative on a present worth basis. It could present the most difficult acquisition problem because of the possible requirement to relocate an entire existing business rather than just their storage space. It allows less system flexibility since the gravity flows from Sunnydale cannot be as easily adjusted in the event downstream facilities in Islais Creek are not constructed and/or overflow requirements become more stringent. Public acceptability is expected to be least because proximity of Alternative 2-1 to residences and community services, and its impact to community traffic flows on Tunnel Avenue, as well as Harney Way.

7. APPARENT BEST PROJECT

APPARENT BEST PROJECT

The apparent best alternative selected for the Sunnydale Transport-Storage Facility is Alternative 2-10. The features of this alternative are shown on Figure 7-1. A profile of Alternative 2-10 is presented on Figure 7-2. In the following description of the proposed facilities, the dry weather flow system is described first, followed by a description of the wet weather flow system.

Dry Weather Flow System

Dry weather flow in the Sunnydale area follows its existing route to the location near the Sunnydale Outfall where the existing 2'-6"x3'-9" sewer currently intercepts this dry weather flow. The 2'-6"x3'-9" sewer would be enlarged to 60"Ø and 66"Ø lines to provide the necessary 60 mgd capacity to the Candlestick Tunnel. Dry weather flow is conveyed by the tunnel to the Yosemite basin where it is lifted by the Griffith Pump Station through a 20-inch force main into the Hunters Point tunnel. From the Hunters Point Tunnel, the dry weather flow gravitates to the Southeast WPCP for treatment.

Wet Weather Flow System

The wet weather flow system, under the apparent best alternative, is shown on Figure 7-1. It consists of a control structure at the existing overflow point; a 5.7 million gallon transport-storage structure along the shoreline, a 50 mgd pumping station, 48-inch force main, and three control structures.

Combined storm flows would follow the dry weather route to the proposed control structure. This structure would divert flows up to 60 mgd through the 60"Ø transport lines to the Candlestick Tunnel. The existing Alana and Harney Way storm sewers would be intercepted by the 60"Ø line and also be conveyed to the tunnel. The tunnel has the capacity of 60 mgd provided that the HGL in Yosemite-

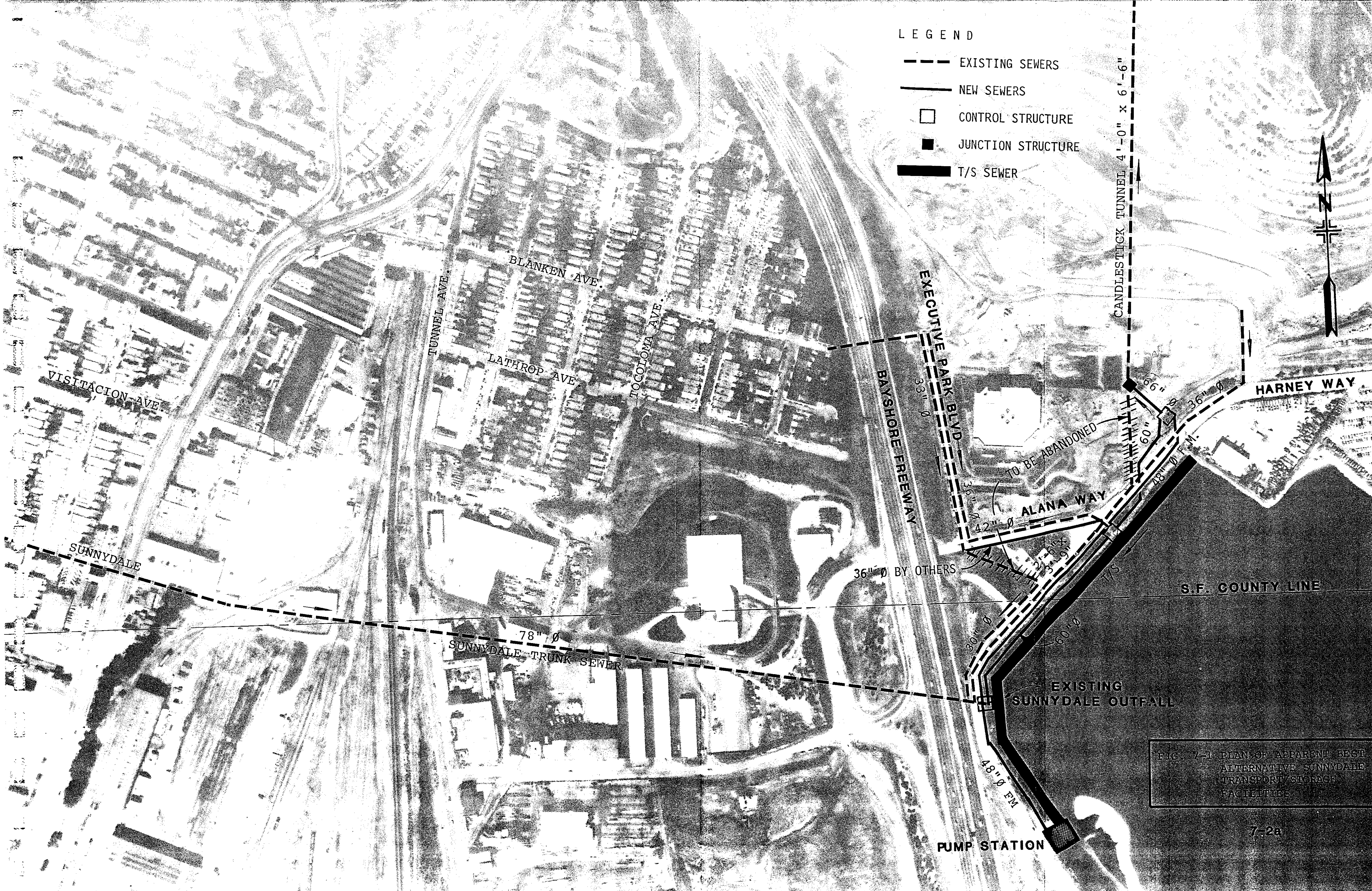


FIG. 7-1 PLAN OF APPARENT BEST ALTERNATIVE SUNNYDALE TRANSPORT/STORAGE FACILITIES

Fitch is below elevation -18 ft. As the water surface in Yosemite-Fitch rises above elevation -18 ft., the capacity of the tunnel is reduced. Excess flows will be diverted to the transport storage structure through the control structures in Harney Way and at the Sunnydale trunk sewer and the intersection of Alana Way. Flows above 60 mgd would overflow a weir in both of the control structures, i.e., in Alana Way and in the Trunk Sewer control structures, and start filling the 5.7 mgd transport storage structure. As soon as the water level in the Sunnydale storage structure is high enough to activate the pumps, the Sunnydale Pumping Station would begin to dewater the stored flows. Discharge of 50 mgd by the pumping station into the Candlestick Tunnel control structure would automatically close a flap gate which prevents the hydraulics in the Yosemite basin from impacting the Sunnydale system. When the gate closes, all flows from the Sunnydale drainage area would go into the storage structure. Once a year, on the average, the storage facility would fill and storm runoff would overflow into the Bay. This excess flow would pass under a baffle to remove floatables before rising over a weir and discharging into the Bay through a new discharge point near the existing outfall location.

As described in Annex I, the use of a pump-dependent system in the Sunnydale area would eliminate the need to transport flows from the Sunnydale Basin independently through the Yosemite System. This would eliminate the need for a second compartment in the Yosemite transport-storage. Furthermore, this would allow use of both sumps in the Griffith Pump Station as a single unit; i.e., the entire 120 mgd pumping capacity of the Griffith Pump Station could be applied against a combination of flows from both Sunnydale and Yosemite Basins, rather than restricting pumping capacity to only 60 mgd for each drainage basin, regardless of the inflow rate.

Sunnydale Transport/Storage Structure and Pump Station

The proposed Sunnydale Transport/Storage Structure is located in the shoreline band southeast of and parallel to Harney Way. It extends from south of the first prominence of Candlestick Point Recreation Area to the Santa Fe Pacific property to the south where the pump station is to be located (Figure 7-1). The profile and sectional details of the Sunnydale Transport/Storage (T/S) structure are shown on Figure 7-2 and 7-3. Details of the pump station are shown on Figure 7-3. A landscaped berm is planned to cover roughly half of the transport/storage structure allowing the remaining portion to be used as a foot path. It is planned that the pump station will be an underground structure. See Figures 7-4 and 7-5.

Construction Methods

Figure 7-6 shows a plan and geotechnical profile of the route of the Sunnydale apparent best alternative. The entire length of the route will be excavated in granular materials (sandy gravel fill and bay mud), younger bay mud and bayside sands. For more information of the geology of the area, refer to the "Geotechnical Investigation-Sunnydale Pump Station/Reservoir Facilities, May 3, 1985" attached as Annex III to this report.

Open Excavation

Most of the route for the apparent best alternative is proposed to be constructed by the open-cut method. It is expected that excavation of the fill and the sand gravel deposits would be relatively easy and can be done by conventional means. The younger bay mud may require special handling during excavation and may be inadequate as a working surface due to its high moisture content and plasticity. It may prove necessary to excavate the bay mud and any other weak material and replace it with granular fill or construct bridge piles to provide an adequate working surface.

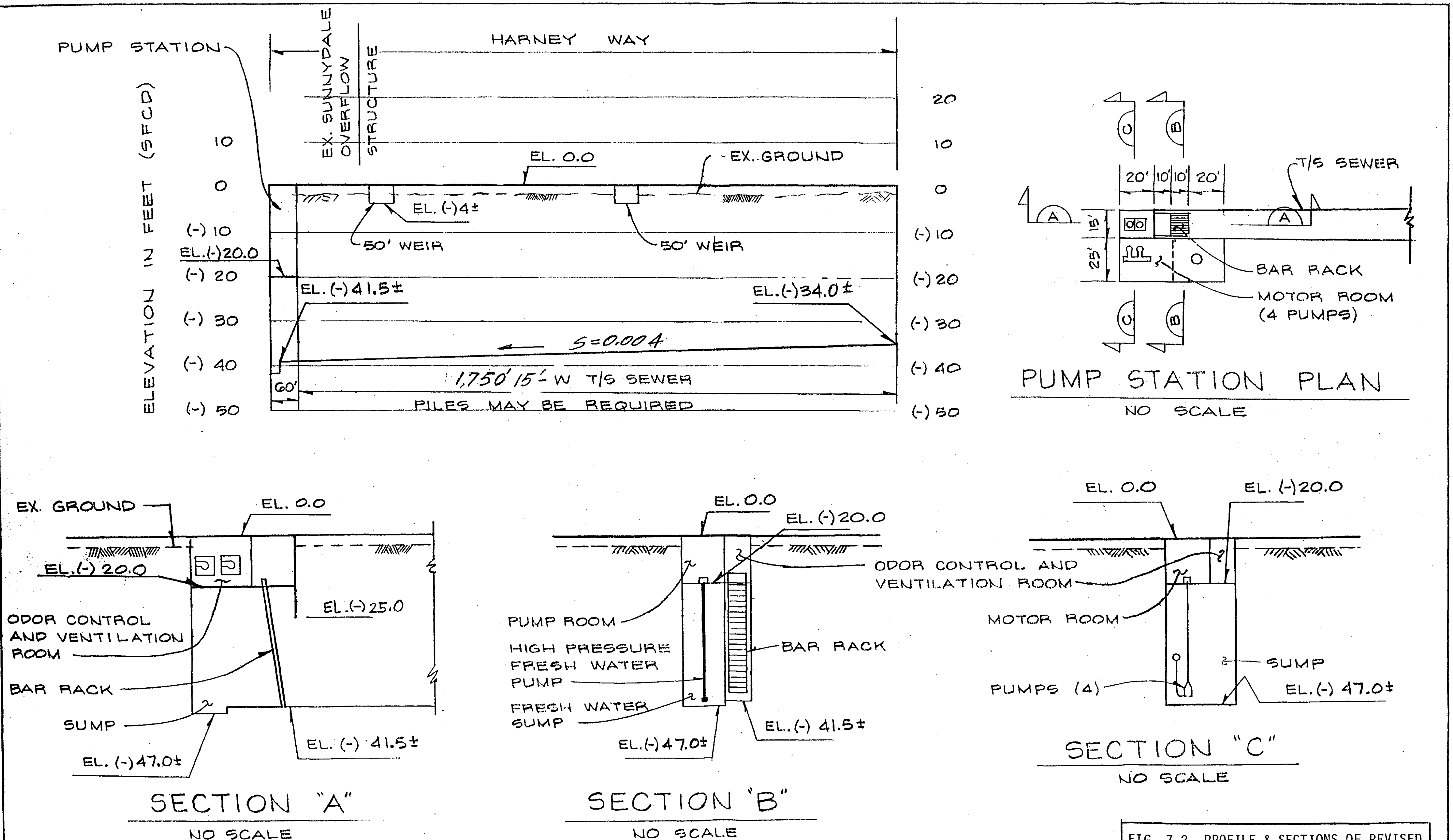


FIG. 7-2 PROFILE & SECTIONS OF REVISED APPARENT BEST ALTERNATIVE SUNNYDALE TRANSPORT/STORAGE FACILITIES

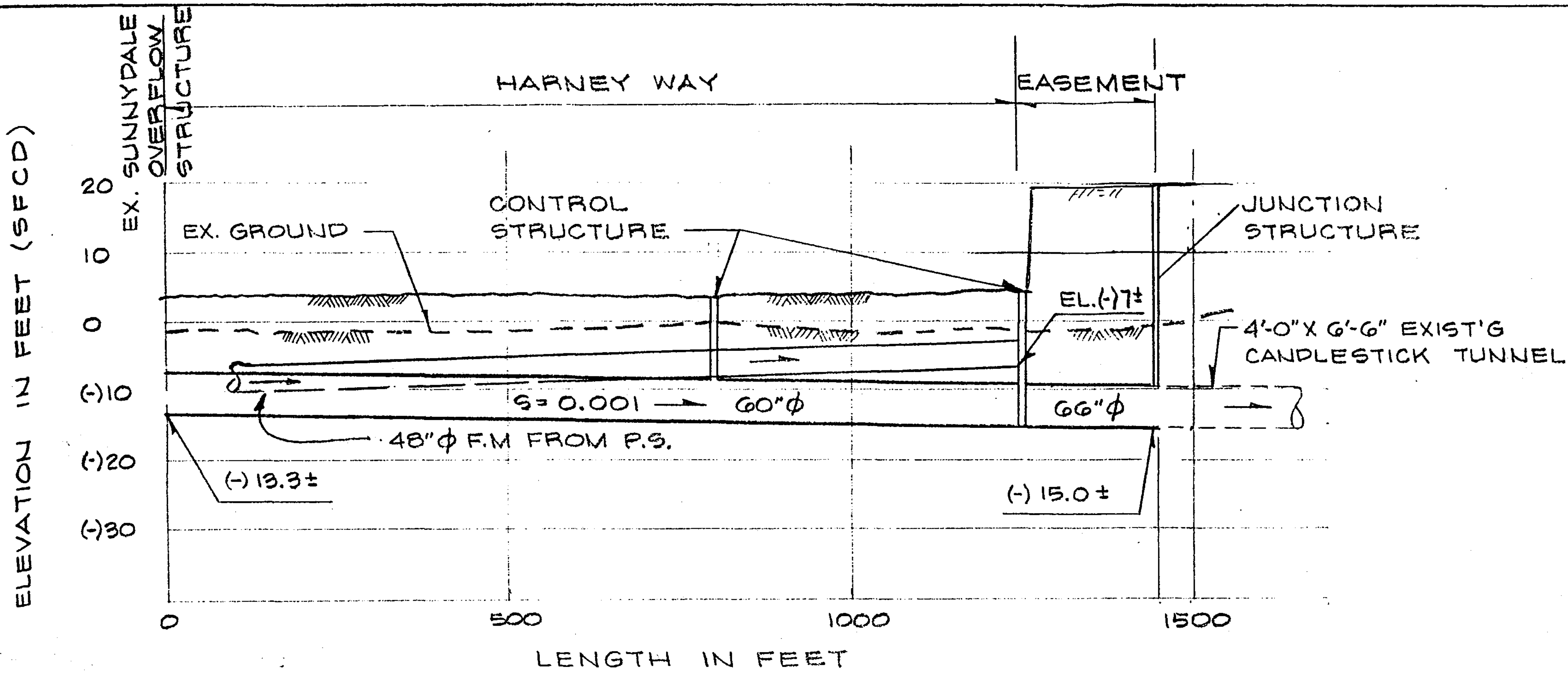
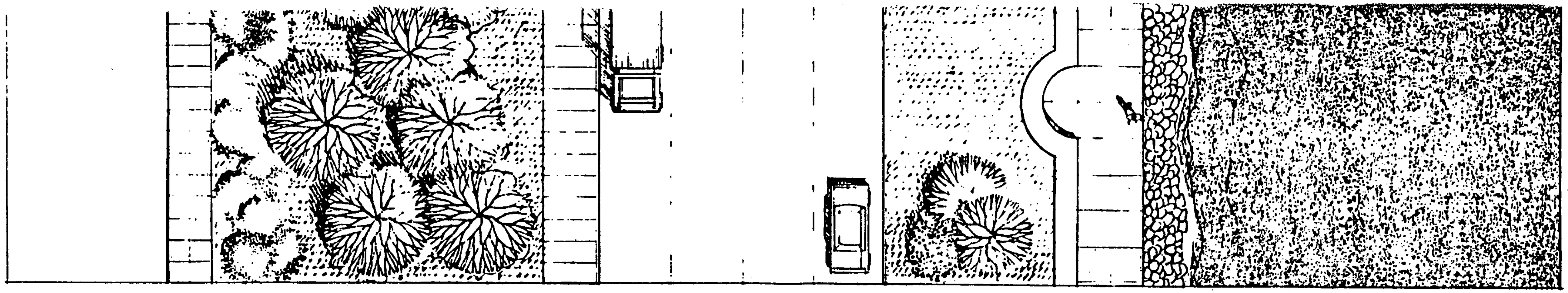
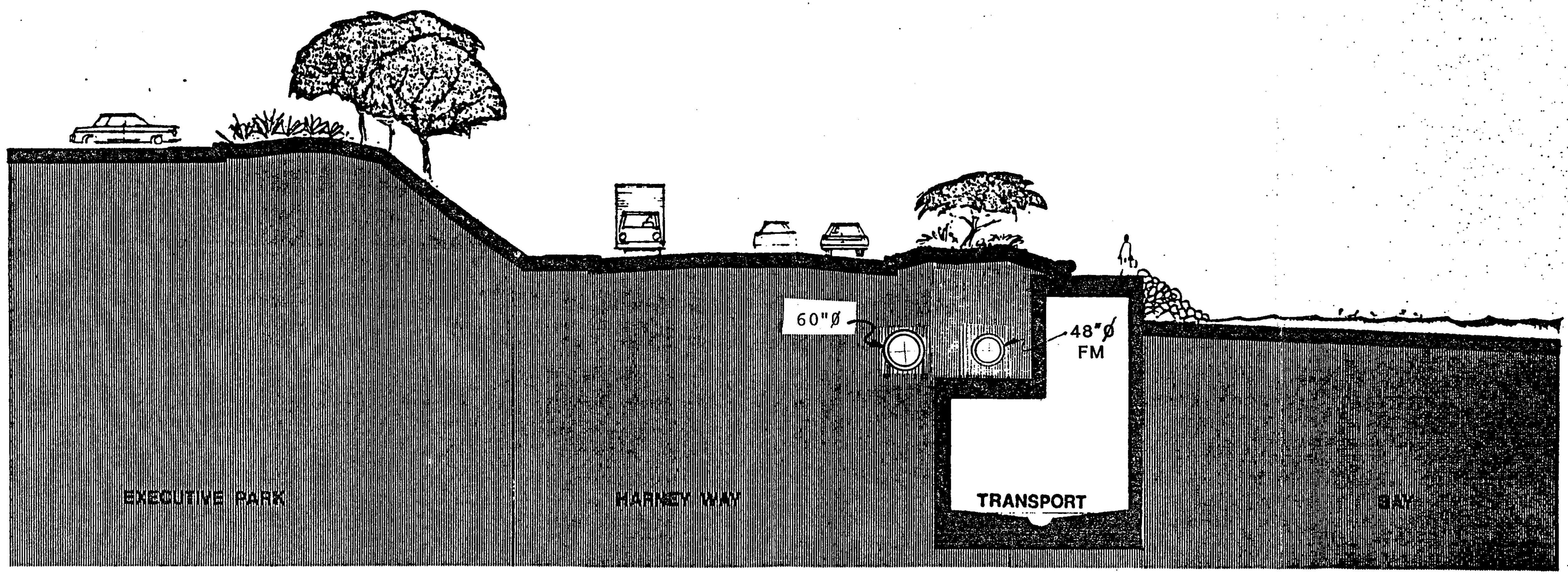


FIG. 7-3 PROFILE OF REVISED APPARENT BEST ALTERNATIVE SUNNYDALE TRANSPORT/STORAGE FACILITIES



PLAN



SECTION

FIG. 7-4 PLAN AND SECTION SCHEMATIC OF SUNNYDALE TRANSPORT/ STORAGE FACILITY

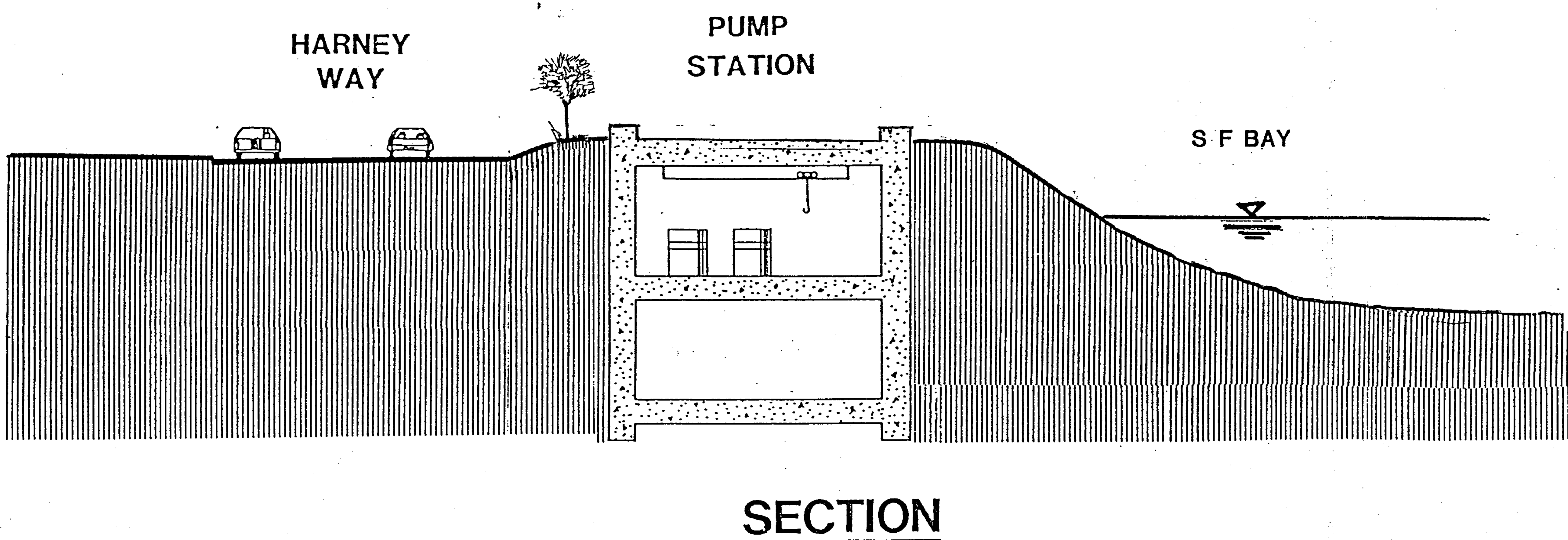
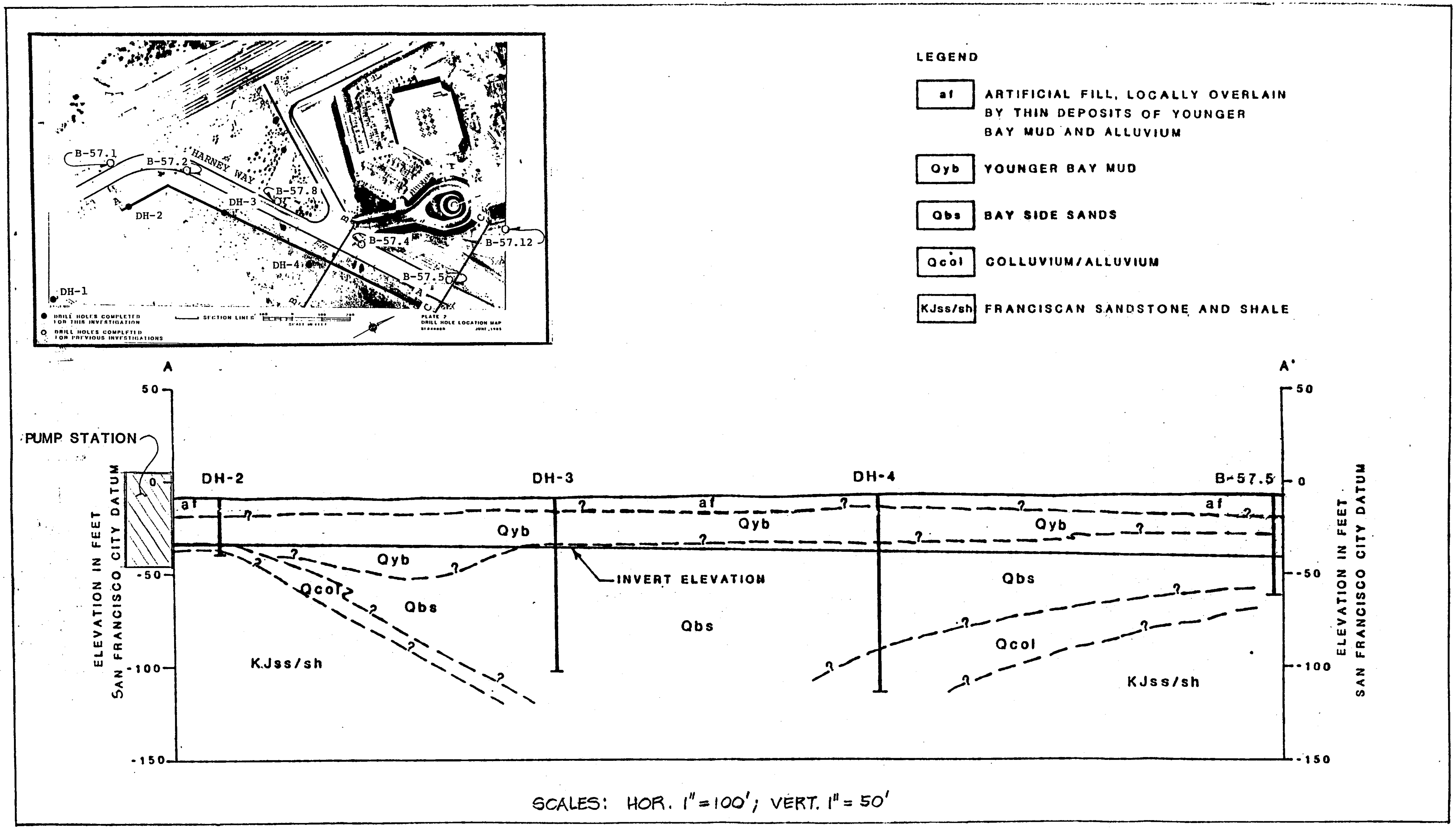


FIG. 7-5 SCHEMATIC SECTION OF SUNNYDALE PUMP STATION



NOTE: SINCE B-57.5 WAS PROJECTED 150 FEET THE CONTACTS BETWEEN DH-4 AND B-57.5 ARE NOT WELL DEFINED.

Figure 7-6 Plan and Geotechnical Profile Apparent Best Alternative Sunnydale Transport/Storage Facilities

It would not be possible to use open-cut excavations with sloping sides because of the work area limitations at the ground surface and traffic lane requirements adjacent to the alignment. Thus, trench sides would have to be retained by a temporary bracing system. The choice of bracing system would depend on the location, depth of excavation, soil and groundwater conditions, adjacent utilities and structures, and anticipated obstructions.

Since most of the fill and sandy gravel deposit excavation would be below the groundwater table, a positive dewatering system must be used in order to ensure a adequate working surface and satisfactory construction conditions.

Sheeting systems such as steel sheet piling or soldier piles and lagging would probably be suitable to retain the trench sides along the soil portions of the alignment. Full interlocking steel sheeting would probably be used to retain the trench walls of the box transport structures in bay mud soils. A possible alternative for the box structures may be concrete walls constructed by the slurry trench method. The slurry wall system minimizes dewatering problems, and the wall can be used as a permanent wall as well as for temporary support.

Traffic Considerations

When in operation, the Sunnydale facilities will be unmanned but will be visited occasionally by a roving operations and maintenance crew. Therefore, traffic disruption due to operation of the facilities following construction will be insignificant. Traffic impacts due to construction activities, however, will be significant.

Foundation Support of Pipelines and Box Structures

Depending on the height of the structure and the subsurface geologic profile, the bottom of the structure could be either in mud or sand. In general, the subsurface geologic profile consists of artificial fill overlying younger bay mud, which in turn is underlain by bay side sand/gravel deposits, and bedrock of the Franciscan Formation.

Bearing capacity and settlement studies were conducted to provide a basis for the preliminary choice of the type of foundation. The results indicate that the bay side sand/gravel deposits, and the bedrock materials would be capable of supporting all of the proposed structures without special treatment. However, the artificial fill and younger bay mud would not provide adequate support in all circumstances.

Due to the heterogeneous nature of the artificial fill, it is difficult to determine its engineering characteristics at all locations. For planning purposes, it may be assumed that the artificial fill would be capable of supporting all of the box structures and all pipelines. The pipelines would not impose loads exceeding the bearing capacity of the artificial fill. The box structures would probably be adequately supported on artificial fill since they distribute the imposed load over a large bearing surface. However, further studies must be made for more subsurface information when design details become available.

The younger bay mud is weak, compressible, and has a relatively low bearing capacity. It is thus capable of supporting only those structures which impose relatively small loads. The box structures may be adequately supported, although further studies must be made. The pipelines may be supported by either pile foundations or by placement of a two to five foot thick layer of granular bedding to distribute the load.

The results of the settlement study indicate that some consolidation of the younger bay mud may occur if the combined weight of the structure (including storm flow), the bedding, and the trench backfill is larger than the weight of the excavated material, or if the thickness of artificial fill or granular bedding material beneath the structure is inadequate to distribute the imposed load. Settlements may be reduced appreciably by supporting the structure on piles, or by using lightweight backfill and bedding aggregate (unit weight of 60 pounds per cubic foot) to reduce the imposed pressure on the younger bay mud to the original soil pressure imposed by the excavated material. Uplift pressure on the box structures, when empty, is a problem which must be considered. A pile or thick mat foundation may be needed to resist the uplift pressure.

Transport/Storage and Pump Station Excavation and Foundation Support

The borings drilled for the preliminary geotechnical investigation are shown on Figure 7-6. Table 7-1 summarizes the ground conditions and geotechnical recommendations at the site. The information and recommendations on Figure 7-6 and in Table 7-1 are approximate and preliminary in nature and would be refined as more information about the ground conditions and proposed construction methods become available.

Energy Requirements

The energy requirements of the apparent best alternative is approximately 109,887 kwhr/yr, as shown on Table 7-2. Annual wet weather energy consumption includes wet weather pumping dewatering, odor control, and flushing requirements. The peak wet weather demand consists of wet weather pumping of 50 mgd from the Sunnydale transport/storage structure, auxiliary services, and odor control and cleaning systems.

Table 7-1 Subsurface Conditions at the Apparent Best Alternative Sunnydale Transport/Storage Site

Description	Subsurface Conditions
Ground surface elevation,[a] ft,	
Highest point	+3.5
Lowest point	-5.5
Average surface elevation	-1.0
Overburden depth, ft.	
Deepest point	26
Shallowest point	24
Average depth	25
Type	Young bay mud, sandy gravel and silty clay
Bay Side Sand	
Highest point	-34
Lowest point	-35
Average elevation	-34
Type	Sand, quartz sand, gravelly sand & chert rock fragments
Groundwater elevation, ft.	-5.5 MHHW
Expected structural bottom elevation, ft.	-47±
Potential problems	Uplift,
Rock excavation method	Blasting or Ripping
Support requirements	Soil: sheet piles, wales, and struts
Probable foundation type	Piles
Bearing capacity, psf	Soil: 2,000 Rock: 30,000
Estimated settlement	Negligible, if on pile foundation
Uplift resistance method	Thick mat foundation or friction piles or rock bolts
Probable dewatering system	Sump pumps
Geotechnical rating	good

[a] All elevations are referred to San Francisco City Datum.

Table 7-2 Energy Requirements for Apparent Best Alternative Sunnydale Transport-Storage Facilities

Power Component	Present and Ultimate[b]
Annual energy consumption, kwhr/yr	
Wet weather pumping	29,455
Odor control	74,100
Cleaning system	441
Auxiliary services	5,891
Total	109,887 kwhr/yr
Peak demand, kw	
Wet weather operations[a]	910 kw

Note: a. Wet weather operations include odor control and flush system energy demands.

b. Present - "C" factor = 0.48
Ultimate - "C" factor = 0.52

Construction Impacts

Construction of the transport/storage structure and the 60-inch pipeline will take place to and alongside Harney Way. Construction of the 66-inch pipeline on Harney Way will take place within the right-of-way and in an easement through Campeau property. At least two traffic lanes will be maintained on Harney Way when construction must take place within the roadway. If necessary, the trench will be covered to provide vehicular access to adjacent properties.

Haul Routing

Potential outbound and inbound haul routes are presented in the Traffic Impacts Analysis Report (Reference 10[a]) for all elements of the Sunnydale Transport/Storage Facility.

Solids Management

In order to identify solids management strategies for the Bayside Facilities, a review was conducted of the operation and performance of existing wet weather transport and storage facilities. Information on

[a] See References in "Bayside Facilities Plan - Southeast Bayside Project Report, March 1982"

solids transport, deposition and resuspension was obtained for various facilities throughout the country, and solids management practices in San Francisco were reviewed. Based on this information, general details and costs were developed for the operation and maintenance of transport/storage facilities.

Solids present in wet weather flow consist of grit, screenings, and scum. It is recommended that solids be contained as much as possible within the sewer system and conveyed to treatment plants for removal and disposal. Grit may tend to settle in transport/storage facilities due to reduced flow velocity. Grit would be resuspended after settling by flushing the facilities with water. After resuspension, the grit would be transported to the treatment facilities for removal and disposal.

The Bayside Facilities Plan, Solids Handling Report (Reference 11) includes preliminary design criteria and considerations for solids handling in the Bayside Facilities. Details and costs are based on the recommended concept of resuspension of solids and transport rather than on direct removal.

There are four possible water sources for solids resuspension: treated wastewater effluent, settled and screened sewage from the transport/storage itself, the City's domestic water supply, and groundwater from wells. In order to utilize treated effluent for cleaning the reservoirs, screens and a high-pressure pump station would be required at the Southeast WPCP with 16-inch pipelines running approximately 21,000 feet to the Yosemite and Sunnydale facilities. Figure 7-7 is a drawing showing a possible route and an alternate alignment for the required treated effluent flushwater system. This installation would cost approximately $6.0 million to construct. By comparison, the supply system utilizing the domestic water supply would cost approximately $24,000 to construct.

On the bay side of the City, feasible groundwater aquifers are limited to deposits of sandy soils with permeabilities high enough to permit groundwater extraction using wells. These deposits of sand are restricted to the subsurface troughs created by old creeks such as Islais Creek and the creek leading to the South Basin Canal. Other areas contain clayey soils with permeabilities too low for practical groundwater extraction.

The deposits of sand in the old creek beds are not extensive, and it is impossible to predict the annual rate at which the aquifers would be recharged without the additional aquifer tests. In addition, it is impossible to predict whether freshwater would flow into the aquifers from the hills or whether saltwater would flow in from the bay. Salty flushing water may prove detrimental to the biological treatment processes at the Southeast WPCP.

Therefore, groundwater cannot be considered for flushing the Bayside Facilities without detailed aquifer testing for the following reasons:

1. The extraction of groundwater may cause local ground subsidence and building damage if the rate of recharge is not great enough.

2. If the rate of recharge is not great enough, the aquifers may have a useful life of only a few years.

3. If the aquifers are recharged largely by water from a bay, the flushing water may become too salty for biological treatment processes.

For the transport/storage elements, preliminary cost estimates indicate that the construction cost for the installation of booster pumps and piping to flush with fire hoses is $41,000, which is used in the project cost estimate, while costs for a fixed nozzle system run approximately 10% of the construction cost for the element itself. Assuming two flushing cycles per month during the six month wet weather period, the fire hose system requires 441 kw/year, while the fixed nozzle system requires 6,300 kw per year of energy for facility cleaning.

Odor Control

General concepts and costs for odor control systems for the apparent best alternative are based on the Bayside Facilities Plan Odor Control Program (Reference 12). In the first phase of the program, a review was made of potential odor problems associated with operation of combined wastewater facilities. A prototype odor monitoring study was developed that focused on the most probable odor problems associated with operation of the proposed facilities. The prototype odor testing was conducted during the winter of 1979-1980 at the Baker Street dissolved air flotation treatment facility and at the Southeast Water Pollution Control Plant. During these tests, odor were monitored from all phases of operation of a combined wastewater storage facility. These phases included facility filling when clean or unclean; flow-through operation; long-term storage (up to 120 hours); facility emptying; and an empty, uncleaned facility. The highest continuous odor emissions came from exposed solids after dewatering a facility. If the facility was rapidly refilled without cleaning, the highest short-term odor emission resulted. Odor impacts from filling a clean facility, flow-through operation, long-term storage, and facility emptying were less significant than this condition.

The potential downwind odor impacts associated with the operation of the proposed Bayside facilities were estimated. These are based on odor emission rates for the various modes of operation and micrometeorological conditions. This analysis showed that the transport/storage at Sunnydale could have potential odor impacts and should be fitted with odor control facilities. It also showed that facility washing after use is an important odor control measure, but that long-term (120 hours) combined wastewater storage would not present a significant odor risk.

Alternative odor control systems were evaluated for Bayside Facilities (Reference 12). The system found to be cost-effective utilizes activated carbon plus permanganated alumina. Sizing and cost of an odor control system is predominantly affected by the ventilation rate. Ventilation rates were selected that would provide odor removal for all air displaced during facility filling at the peak inflow rate for a one-year storm and also provide six air changes per hour for manned entry. The fan capacities will also provide a minimum of two air changes per hour within the total transport/storage volume when empty. The odor control systems will only operate intermittently during the wet weather season. A total fan capacity of 30,000 cubic feet per minute (cfm) is required for the transport/storage facility. Two 50-horsepower fans would be provided. Figure 7-8 is a schematic diagram showing pertinent features of the odor control system for the transport/storage facility. Flexibility and reliability are provided by multiple fan and odor control units.

Construction costs for odor control are included in the detailed cost estimate for the apparent best alternative. The annual operating and maintenance (O&M) cost is determined by estimating power costs based on intermittent operation for seven months per year, and adding costs for general maintenance and replacement of the absorption material. The annual O&M cost for odor control is estimated at $5,600.

Land Use

Land to be used for the proposed project is zoned "public". The proposed project site, north of the San Mateo County line, is a partially developed portion of the Candlestick Point State Recreation Area. The site area south of the County line is comprised of undeveloped State lands, Santa Fe Pacific Property and the existing Sunnydale Outfall easement.

The master plan for the Bay (reference the San Francisco Bay Plan, BCDC, as amended September 1983) calls for a public access way connecting Sierra Point, in Brisbane, to the Candlestick Point State Recreation Area. As part of the project, it is proposed to place a landscaped berm extending from the shoulder of Harney Way covering roughly half of the transport/storage structure. The remaining half of the structure along the Bay would be developed as a public access walkway. This would develop 1750' of the Master Plan public access and return the entire transport/storage site to public use. Figure 7-4 shows the plan and profile (artist's concept) of the transport/storage structure treatment.

In order to render the pump station structure as unobstrusive as possible in a park setting, it is proposed to construct an underground pump station structure with a viewing area on top. This treatment of the pump station would return the area to public use. Figure 7-5 shows a conceptual cross section of the pump station.

Visual Conditions

The dominant visual features of the proposed project area are the freeway, the Bay, the San Francisco Executive Park development, the Candlestick Point State Recreation Area and undeveloped shoreline. Currently, only three office buildings have been completed on the San Francisco Executive Park site. Future development plans for this site include additional commercial and retail buildings, a hotel, a restaurant, and high density housing, all interspersed with landscaped areas.

The integrity of the shoreline and Harney Way, which runs parallel to the project site, is currently maintained by the loose placement of rubble consisting of broken pieces of concrete, pavement, curbing, and cut stone. Visual inspection shows that the shoreline has begun to erode in many places and that it is being used as a refuse dumping site. The BCDC Bay Plan calls for a public access route along the shoreline which will eventually join the Candlestick Point State Recreation Area with Sierra Point in Brisbane. In the future, with park development and the degree of landscaping in the San Francisco Executive Park, with the exception of the freeway, the area will have a predominantly park like flavor.

The transport/storage structure would be constructed as much as possible into the existing shoreline. From the shoulder of Harney Way to roughly mid-point of the 15'-20' wide structure, approximately 12', a low landscaped berm is proposed (see Figure 7-4). The remaining portion of the structure would provide a public walkway along the Bay. It is planned to landscape the berm with low growing vegetation. The berm will drop from Harney Way at approximately elevation 5' to the top of the structure at elevation 2.5' (City Datum). This will buffer views of Harney Way from the walkway without blocking views from adjacent development. From the Bay itself and portions of the

Candlestick Point Recreation Area, roughly 5' of the side of the transport/storage structure will be visible. Discussions are currently underway with State Park and BCDC on various methods of providing access from the walkway to the Bay and naturalizing the visible portion of the structure.

It is planned to have an underground pump station, thus making it compatible with the surrounding park development (see Figure 7-5). Ground elevations on the adjacent roadway is approximately 1.5 feet. The top of the pump station would be at an elevation of approximately 3', thus no views from the San Francisco Executive Park would be blocked.

Wildlife Habitat

The 1978 survey conducted by James Sutton (reference "Survey of Sport Shellfishing Potential in the San Francisco Bay, etc." December 1978), identified a minor clam population in the construction area of the proposed project. The primary species identified were the mya (softshell clam) and the tapes (Japanese little neck clam). A recent re-examination of this clam bed revealed a marked decline in its population. The tapes and mya survive primarily between elevation -9' and -12' and prefer a crushed rock type environment. In order to encourage repopulation of the clam bed, it is proposed that as part of the project, at the appropriate elevations disturbed by the construction, a crushed rock substrata could be placed during surface restoration activities.

Control System

A control system is required to make the wastewater facilities function properly as a whole to reduce overflows of combined sewage to the levels prescribed by the NPDES discharge permits.

Summary Results of the Control System Program

As part of the Bayside Facilities Planning Project, a study was conducted to determine the most cost-effective method for flow management and automatic control of the major wastewater facilities throughout the City. The principal objective of that study was to develop a city-wide control system that would interface with the local dedicated controls at the remote facilities during storm conditions and regulate their operation for optimum utilization of available storage and treatment prior to any overflow event. The results of that study were published in the City-Wide Control System Report, dated February 1981 (Reference 13).

The city-wide control system, as recommended by the report, is based upon a supervisory control concept. This concept utilizes local dedicated controllers at each physical facility to carry out the flow management and control decisions made by the supervisory control system. The recommended control system is based upon a distributed and hierarchical configuration consisting of a supervisory control center (SCC), two area control centers (ACCs), and several field terminal units (FTUs) which provide the necessary interface between the various local controllers and the supervisory control system. An interim control system is under design. Figure 7-9 shows a schematic diagram of the designed system. Figure 5-16a shows the alternative routes for the fiberoptics cable transmission line.

Control of Sunnydale Facilities

Based upon the supervisory control concept, discussed above, local dedicated control systems will be required for the Sunnydale Facility. These control systems will perform the following functions:

1. Control the local mechanical equipment based upon the set point commands received from the city-wide supervisory control system through the bayside ACC.

2. Operate the facilities in a safe manner in case of communication failure between the supervisory system and the local controls. If communications are lost between the bayside ACC and the local dedicated control systems, the local systems will continue to provide reactive control of the local facilities without receiving any supervisory commands.

Generally, conventional and microcomputer are the two types of control equipment which are applicable for local controls. The microcomputer-based control systems are more reliable than conventional systems and require less maintenance. In addition, microcomputers are generally more cost competitive in larger applications. Therefore, the basic automatic controls for the Sunnydale Transport/Storage Facility will utilize a microcomputer-based control system.

The greatest benefit from microcomputer technology is obtained when all control functions in a single facility are combined into a single computer. This reduces the number of mechanical devices and the required interconnections. However, in order to prevent potentially catastrophic failures due to computer malfunction, conventional protective devices must also be provided for critical control functions. The exact balance between the computer hardware and conventional hardware will be determined during design since the local instrumentation needs and complexity can never be fully anticipated during the planning phase. The designer can balance the design considering not only the costs, but also the reliability requirements for each control function.

In general, it will be desirable to utilize the microcomputer for sequential control, such as the speed regulation and sequencing of the various pumping units, and conventional hardware for critical interlocks, such as low and high wet well level switches for stopping and starting pumps.

Operations and Maintenance

The continual successful performance of the Sunnydale Transport/Storage Facility will rely on a good operations and maintenance program.

Standard Operations and Maintenance Procedures

Most of the operational requirements for the apparent best alternative are associated with the Sunnydale pumping station. These operation requirements will vary significantly with the season.

During the dry weather season, flow is transported through the sewer facilities to the Y/F system to the Southeast WPCP for treatment. Operations and maintenance activities in Sunnydale will consist of maintaining flow through the existing sewers. A minimum of attention will be required by operating personnel during dry weather.

The Sunnydale Pumping Station will operate during and after each major storm. These pumps are expected to receive wear since they will pump out grit and solids deposited in the structure. The dry weather season is the best time to perform major maintenance on wet weather pumps and associated equipment since they will not need to be placed in service at short notice.

The use of electric motors to drive all the pumps eliminates the problem of frequent exercise that would be required to keep internal combustion engines ready for service. Electric drives also require a minimum of maintenance for wear.

Staffing Requirements

The operations and maintenance of the facilities will be the responsibility of the Department of Public Works, Bureau of Water Pollution Control. Personnel requirements will be greater during wet weather months than dry weather months. No permanent on-site personnel will be assigned to the facilities at any time; roving crews will periodically inspect the facilities. The recommended staffing requirements for the apparent best alternative is presented in Table 7-3.

Training

A training program will be initiated to train personnel in the operation and maintenance of the Sunnydale Facilities. The training program will consist of both classroom sessions and "hands-on" sessions where the operators actually work with the installed equipment. For this reason, the training program will be coincident with the start-up period following completion of construction of each stage. The training program will cover normal and emergency operations during both dry and wet weather, flushing and cleaning operations, and routine maintenance procedures.

Detailed Cost Estimate

Detailed, unescalated cost estimate for the Sunnydale Facility is presented in Table 7-4. The cost estimate is based on construction bid and land costs as of January 1985 (ENR 5044). Detailed escalated project costs will be provided when implementation schedules for the facilities become available. These schedules are fully dependent on the availability of Federal and State funding which cannot be predicted at the time of this report.

Estimated annual costs of labor and materials for the operations and maintenance of the Southeast Bayside Project are presented in Table 7-5, and the estimated annual electrical energy costs to operate the facilities are presented in Table 7-6. These costs are based on January 1985 prices.

Table 7-3 Recommended Staffing Requirements for Apparent Best Alternative Sunnydale Pumping Station and Transport-Storage

Staff Classification	Sunnydale Pumping Station (days per year)	Transport/Storage Structures (days per year)
Superintendent	25	-
Foreman	53	-
Operator*	182	-
Custodian crew	63	-
Cleaning crew	-	56
Maintenance crew	17	20
Total	340	76

* Roving crew 2 men X 2 hrs/day

Table 7-4 Estimated Costs of Apparent Best Alternative Sunnydale Facilities

Cost Item	Cost, millions of dollars
Construction contract	
Pumping Station	
Excavation, Structural & Backfill	2.300
Electrical/Instrumentation & Mechanical	1.700
Subtotal	4.000
Box conduits	
Excavation, structure, backfill, piles and restoration	9.740
Cleaning system	0.041
Odor control system	0.605
Circular sewers	
Excavation, pile foundation, conduit, backfill, and restoration	1.863
Misc. Structures & Landscaping	1.536
Subtotal	13,785
TOTAL CONSTRUCTION	17.785
Land	0.411
Contingency 10%	1.820
TOTAL CAPITAL	20.016
Present Worth of O&M	1.890
TOTAL PRESENT WORTH	21.906

ENR 5044, January 1985

Cost for 50 MGD pumping rate

Table 7-5 Estimated Annual Costs of Labor and Materials for Operation and Maintenance for the Sunnydale Project

Facility	Cost, thousands of dollars		
	Labor	Materials	Total
Sunnydale Pump Station	134	30	164
Sunnydale Transport/Storage Element	6	0	6
Total	140	30	170

Table 7-6 Estimated Annual Energy Costs for the Sunnydale Project

Facility	Cost, thousands of dollars					
	Pumping		Odor Control	Cleaning	Auxiliary Services	Total
	Dry Weather	Wet Weather				
Sunnydale Transport/ Storage Facility	0	2.6	6.4	0.6	0.5	10.1

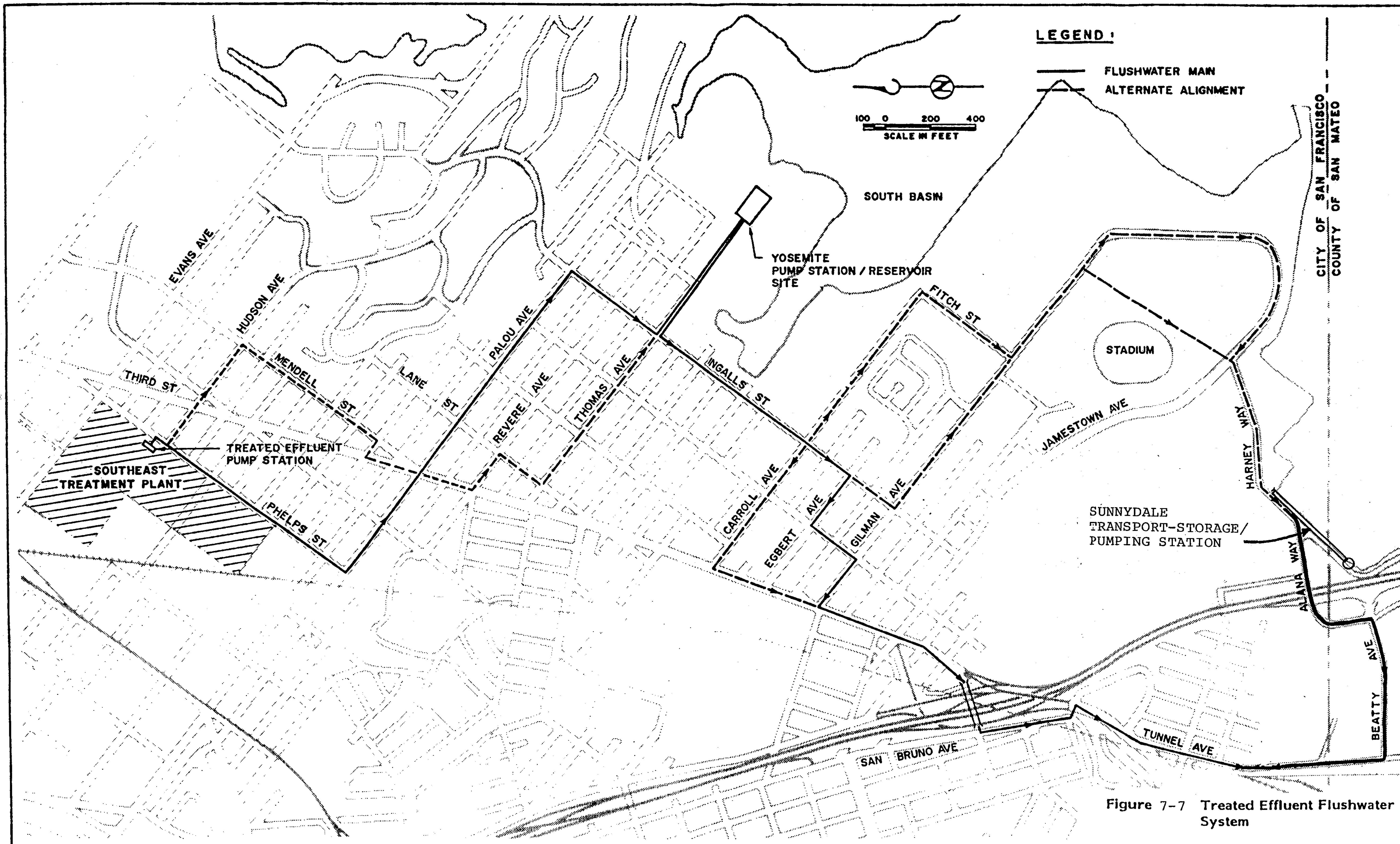


Figure 7-7 Treated Effluent Flushwater System

CALDWELL-GONZALEZ-KENNEDY-TUDOR
A JOINT VENTURE

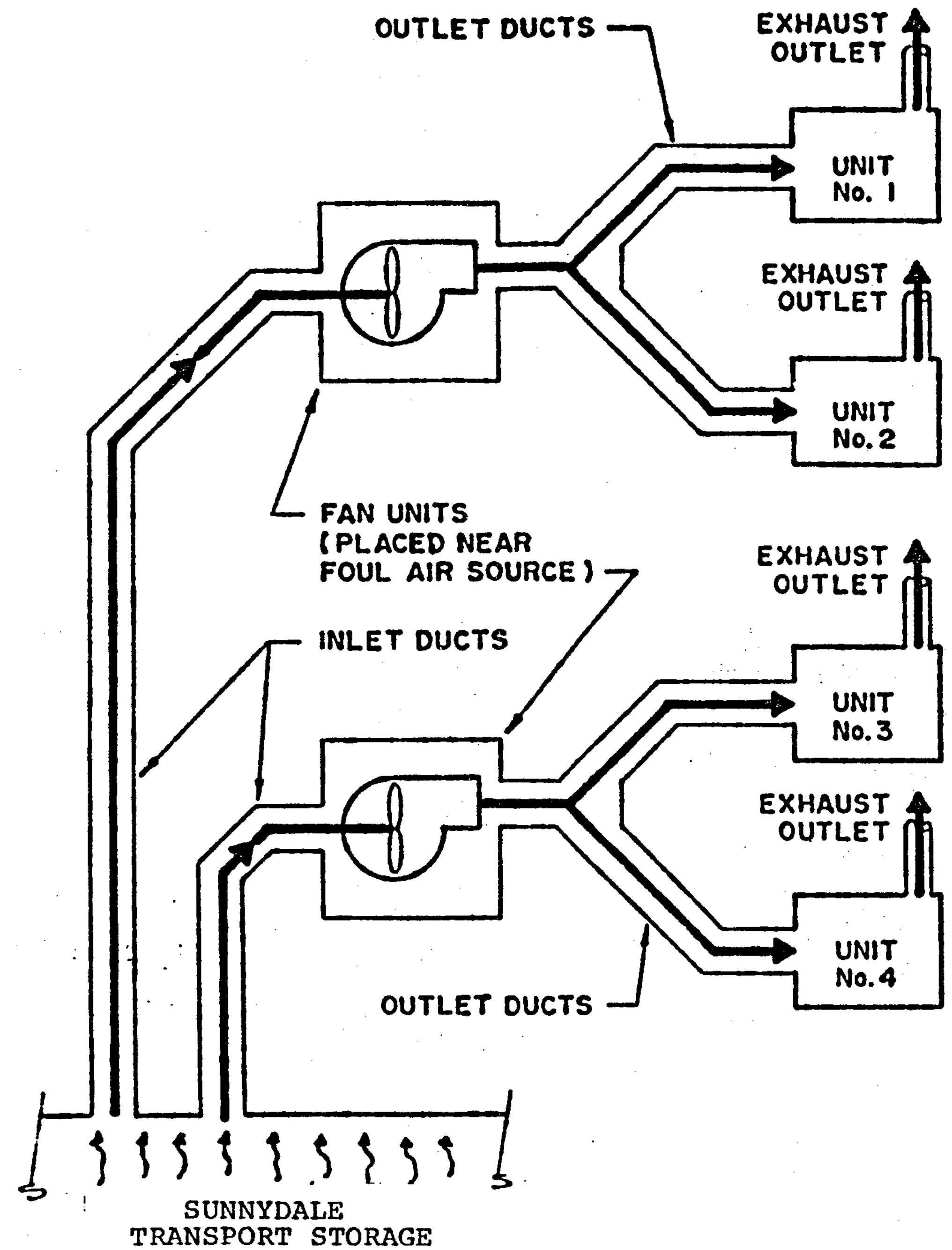


FIG. 7-8 ODOR CONTROL SYSTEM

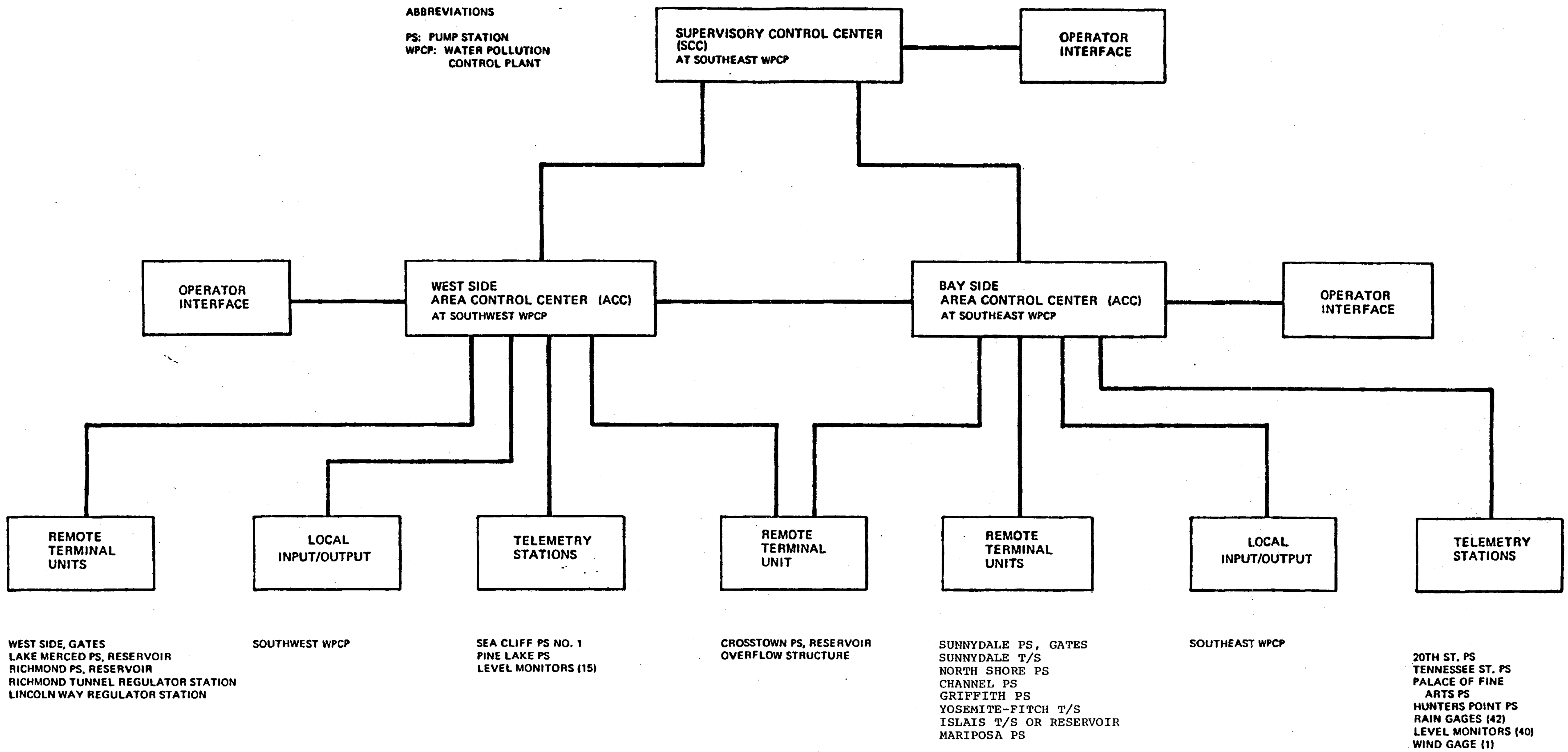


Figure 7-9 Citywide Control System

8. REVENUE PLAN

REVENUE PLAN

The San Francisco Clean Water Program is responsible for financial planning for each of the project elements of the City's wastewater program. The financial plan and revenue program is described in the Official Statement City and County of San Francisco Relating to $50,000,000 Sewer Revenue Bonds, Series B dated March 30, 1981, prepared by Blyth Eastman Paine Webber & Co., Inc., and Stone & Youngberg Municipal Financing Consultants, Inc.; and the 1983-84 Clean Water Enterprise Revenue Plan, May 18, 1983, prepared by the Department of Public Works.

Sources of Project Funds

Three major sources of funds are used to finance sewerage projects: Federal grants from EPA, State grants, and local revenue bonds and general obligation bonds authorized for sewerage purposes.

The Federal grants are authorized under the Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500, which provides up to 75% of the eligible costs of publicly owned wastewater facilities approved by the EPA. The 1981 Amendments to the Act, Public Law 97-117, added Section 201(n)(2), authorizing Congress to appropriate

$200 million per year as a supplemental amount to rectify water quality problems caused by combined sewer overflows in marine bays and estuaries. The Bayside Facilities Project qualifies to receive 75% Federal share funding under Section 201(n)(1), 201(n)(2) and 201(g)(1) of the Act. The project has always been recognized to be sequential phase of the Clean Water Program's overall water pollution control system, set forth as Stage II of the Master Plan. (See Overview Facilities Plan, August 1975; Final Environmental Impact Report Southeast Treatment Plant, San Francisco Wastewater Master Plan Implementation Program II, April 1975.)

The State grants, at 12.5% of project eligible costs, are derived from general obligation bonds authorized under the Clean Water Bond Law, as extended in June 1978. Federal and State grants are administered by the State Water Resources Control Board.

The City is responsible for 12.5% of grant eligible costs, all grant ineligible costs, and cash flow requirements during construction or approximately 20% of the total project costs. The City plans to meet its funding requirements from three sources: (1) Currently available unencumbered funds; (2) net proceeds from the sale of portions of a $240 million Sewer Revenue Bond authorization approved by the electorate on November 2, 1976; and (3) income from the investment of Sewer Revenue Bond proceeds during construction.

Sewer Revenue Bonds are issued pursuant to Resolution No. 973-77 of the Board of Supervisors. Section 6.15 of Resolution No. 973-77 provides that the City shall at all times, while any of the bonds remain outstanding, fix and collect rates, fees, and charges for services of the sewerage system so as to yield net revenues in each equal to at least 1.25 times debt service becoming due on the bonds in that year.

Financing Capacity

Sewer service charge rates and procedures, in compliance with the State Water Resources Board Revenue Program Guidelines, were adopted in June 1977 and approved by the EPA. Sewer service charges are subject to annual review and update, as required by law. The current sewer service rates, and systemwide operations, maintenance and debt service costs are described in detail in 1983-1984 Clean Water Enterprise Revenue Plan. The 1983-1984 Clean Water Enterprise budget provides a debt coverage ratio of 2.32, which is almost twice the coverage required under the City's bond ordinance.

The above description of the Revenue Plan was prepared by the Clean Water Program staff.

A SUMMARY REPORT OF
PLANNING AND DESIGN FOR
YOSEMITE FITCH AND SUNNYDALE DRAINAGE BASIN
CSO FACILITIES

June 1985

INTRODUCTION

The purpose of this report is to provide a summary of the planning and design analyses undertaken in the Yosemite/Fitch and Sunnydale drainage basins and the conclusions reached during those phases of the work on the respective projects. Discussion also will include the effect of decisions made for Sunnydale Basin upon the required facilities for Yosemite/Fitch drainage basin overflow control.

BACKGROUND

Facility Planning for the Southeast District of the City, completed in March, 1982 and amended in 1984, described a series of works required for the control of combined sewer overflows (CSO). The facilities included the following elements:

- Hunters Point Facilities
- Southeast Sewer Modifications
- Southeast Plant Modifications
- Griffith Pump Station and Force Main
- Yosemite/Fitch Outfalls Consolidation
- Griffith Reservoir
- Shafter Avenue Outfall
- Sunnydale Outfall

These projects were planned in such a fashion as to allow a sequential system development, providing progressive benefits and matching, to the extent possible, the expected availability of funds. Plans and specifications have been completed and bids received for the first three of the elements namely.... Contracts are expected to be awarded by August, 1985. Plans are nearly completed for the Griffith Pump Station. Plans were completed for the Yosemite/Fitch Outfall Consolidation in January, 1985 and transmitted to the SWRCB.

The apparent best alternative (ABA) developed was the result of the evaluation of a series of system alternatives. These ranged from all tunnel construction to various combinations of transport/storage and pumping from alternative locations.

The ABA for the Yosemite area contained a 120 million gallon per day (mgd) pump station utilized in conjunction with 16 million gallons (mg) of storage and a new outfall at a less confined location. An existing tunnel through the Hunters Point ridge, with a surcharged capacity of 120 mgd during peak storm periods, provided the means to remove flow from the drainage basin. The southern-most drainage basin in the City, immediately to the south of the Yosemite basin, also is topographically surrounded by a ridge through which one existing tunnel provides a means for exporting flow. The selected alternative in Sunnydale contained a 10 mg reservoir and a 60 mgd lift station to match the capacity of the existing tunnel. These facilities for the Yosemite/Fitch and Sunnydale basins are described fully in the Bayside Facilities Plan, Southeast Project Report prepared by the joint venture of Caldwell-Gonzalez-Kennedy and Tudor Engineers, (CGKT) dated 1982.

YOSEMITE BASIN DESIGN

The design of the facilities in the Yosemite drainage basin was undertaken with the following criteria:

- The long term statistical average of combined sewer overflows (CSO) would be one per year to meet NPDES permit requirements.

- The system must have the capability to transport the City standard 5 year design flow to the ultimate point of discharge.

- The designed system must provide a system hydraulic grade line which is no higher than gutter level at Official grade elevations.

- The system must not cause surcharging and flooding in the tributary area.

- The system must provide the ultimate capability to eliminate the overflow in the confined head end of the Yosemite Canal.

- A new outfall would be designed to provide a system discharge location at a less confined location out of the head end of the Yosemite Canal.

- Required system storage over and above that inherent in the required transport lines would be designed and constructed at the only available City property (bounded by Griffith, Fitch, Shafter and Underwood Avenue.)

- Overflow structures would be baffled to restrict the discharge of floatable material.

- The system design must address the projected State Park development in the Yosemite Canal area.

- The system must be designed in such a fashion that it would be self-cleaning and would not generate odor.

- The system would be designed to address the planning period defined in the facility plan (i.e., the year 2000) and in accordance with planning guidelines.

- The runoff factor in both the Yosemite and Sunnydale drainage basins would be 0.60.

- There would be no hydraulic interconnection between the Yosemite Transport/Storage Facilities and the Sunnydale Facilities. This would require a separate transport chamber for Sunnydale flow and an isolable part of the Griffith Pump Station to dedicate 60 mgd to the Sunnydale area.

These are the same criteria utilized in the planning study.

The resultant design included:

- o A 120 mgd Griffith Pump Station which contained two 60 mgd sumps.

- o A reinforced concrete dual compartment box structure varying in size from 18 to 20 feet wide containing eight (8) mg of storage.

- o A reinforced concrete detention reservoir with a volumetric capacity of seven (7) mg of storage.

- o A new outfall discharge point at the foot of Shafter Avenue.

- o The existing sewer system which contributes one (1) mg of storage.

As design progressed in the Yosemite basin, it became obvious that, because of changes in the requirements of various regulatory agencies, a re-examination of the plan for the Sunnydale area to the south could possibly achieve significant savings in the Yosemite basin and probably in the Sunnydale basin. Since there was no way to predict the outcome of the re-examination, the plans for Yosemite/Fitch transport/storage structure were designed in such a fashion to allow flexibility to accommodate two possible alternative concepts for the Sunnydale area.

The Yosemite/Fitch Outfall Consolidation project was designed to accommodate either a pump or gravity solution for the ~~Sunnydale~~ area. The gravity solution from Sunnydale would require a separate compartment in the Yosemite/Fitch project to separate and isolate the two system hydraulic grade lines so as to dedicate 60 mgd to the Sunnydale area. The pump solution would not require a separate compartment. The solution was to eliminate the interior compartment in the Yosemite/Fitch transport storage and to shape the bottom so that a future ~~line~~ could easily be installed if required.

In summary, the Yosemite facility design was completed using the aforementioned criteria for capability to transport the 5-year flow to a point of ultimate discharge and not violate hydraulic grade line requirements. The resulting box structure had the inherent volume to provide a portion of the required system storage. The Yosemite facility was designed with the concept that any additional storage to meet overflow control requirements would be included in the Griffith Reservoir and Shafter Avenue projects.

SUNNYDALE AREA PLANNING

Because of changes in various agency planning constraints, it became obvious during the planning re-examination that a combination of facilities at or near the shoreline could result in substantial savings. The option to use a pumping solution in Sunnydale became more attractive as downstream areas closer to the existing Candlestick tunnel portal were made available for examination.

A new interactive analysis of the two drainage basin facilities was performed using a refined computer model during the investigation of the Sunnydale Facilities (see Appendix ~~A~~B). It was found that a pump solution from Sunnydale will eliminate the need for the second compartment in Yosemite/Fitch structure; effectively providing an additional 0.7 mg storage. In addition, using the pump solution from Sunnydale, 1 mg of storage becomes available in the Candlestick Tunnel for the flow from both of the areas. In effect then, the design for the Yosemite/Fitch system included the following storage:

8 mg	Transport/Storage
1 mg	Existing System
1 mg	Candlestick Tunnel
0.7 mg	Storage gained by eliminating second compartment in Yosemite/Fitch
10.7 mg	Total Storage

This was a net gain of 1.7 mg of additional storage by <u>not constructing</u> the second compartment.

In addition, computer analysis showed that more efficient use could be made of the Griffith Pump Station when the flows are combined in the Yosemite/Fitch Transport Storage. Instead of having a 120 mgd pump station, there were in effect, two separate 60 mgd pump stations, one for each drainage area. With the Sunnydale pump solution, the full 120 mgd capacity could be utilized to pump the flow combination. This produced additional efficiency and decreased the total required storage in the Yosemite/Fitch drainage basin. The computer runs with the more refined model showed that with a 120 mgd Griffith Pump Station, the total storage required for Yosemite with a pump solution from Sunnydale, is 14.1 mg. This provides a saving of 1.9 mg, or a requirement of only 3.4 mg more than that provided by Yosemite/Fitch transport/storage facility.

Analysis also was undertaken to review runoff coefficients for both the Yosemite and Sunnydale areas (see Appendix ~~B~~ A). The Yosemite basin is substantially residential in nature with some commercial and industrial areas in the lower parts of the drainage basin. It was determined that there was, in effect, little or no additional develop-possible in this basin and the utilized runoff coefficient of 0.6 is reasonable. A review of the Sunnydale drainage basin indicated a substantial amount of park area which will not change in zoning. There are some undeveloped areas near the head waters and in the lower lying parts of the drainage basin. An evaluation of the drainage basin on sub-area basis has indicated that the present runoff coefficient for the Sunnydale basin is 0.48. The most likely ultimate development of the area would produce a runoff coefficient of 0.52. It is considered that this condition will occur within the facility planning period.

Utilizing the above information, additional computer runs were made to determine any further reduction in required overall storage. Further, refined computer analysis with all of the foregoing considerations resulted in the following tabularized values based on recommendations in Appendix B:

	Yosemite Basin	Sunnydale Basin
Present Development		
Runoff Coefficient	0.6	0.48
Storage Volume Required MG	11.5	5.7
Nominal Pump Station Capacity MGD	120	50
Ultimate Development		
Runoff Coefficient	0.6	0.52
Storage Vol. Required MG	12.7	5.7
Nominal Pump Station Capacity MGD	120	60

The storage volume of 11.5 mg required in the Yosemite Basin for present conditions can be obtained by substituting an 18 foot wide box sewer for the 96-inch pipe on Bancroft Street between Fitch and Griffith Streets. The additional 1.2 mg for ultimate development can easily be achieved in the Shafter Avenue Outfall project by designing a reverse slope facility. Thus, the Griffith reservoir is not required either for present or ultimate conditions.

STUDY CONCLUSIONS

1. The completed Yosemite/Fitch design (2/85) with a small increase in storage has the appropriate storage volume (11.5 mg) to achieve one overflow per year for present conditions without the need for the Griffith Reservoir.

2. The completed Yosemite/Fitch transport/storage design has been shown in design document calculations to be the minimum to meet hydraulic criteria and to transport City system design flows to a point of ultimate discharge. See also Appendix C, a cost analysis.

3. A pump dependent Sunnydale Solution reduces required storage in the Yosemite basin by 1.9 mg. Estimated system savings may be on the order of magnitude of $3.8 million.

4. A pump dependent Sunnydale Solution will generate an additional storage benefit of 1.7 mg in the Yosemite basin. Estimated system savings may be on the order of magnitude of $3.4 million.

RECOMMENDATIONS

1. The design of the Yosemite/Fitch Outfall Consolidation should include the capability to transport City 5-year design flows to an ultimate discharge point off Shafter Avenue, thus allowing the flexibility to eliminate three outfalls that discharge to the confined end of Yosemite Canal.

2. Because the Yosemite/Fitch transport/storage facility has sufficient volume to achieve one overflow per year, (present conditions), delete the Griffith Reservoir from the system.

3. In the future, develop required Yosemite basin storage in a reverse slope Shafter Avenue Outfall.

4. Adopt the pump dependent solution in the Sunnydale basin, designing the station with the capability to be expanded from

50 mgd required for present conditions to 60 mgd for ultimate development, the cost of this flexibility should be minor, representing slightly larger electrical conduits/equipment.

5. Construct 17.2 mg total storage (11.5 mg in Yosemite and 5.7 mg in Sunnydale) to meet the required NPDES overflow level of 1 per year, ~~which~~ with present area development conditions.

APPENDIX A

SUNNYDALE-YOSEMITE CSO PROJECTS

GRAVITY VERSUS PUMPING

SUNNYDALE-SYSTEM

MAY, 1985

by

C. A. Phanartzis

HYDROCONSULT-ENGINEERS

for

CLEAN WATER PROGRAM

CITY AND COUNTY OF SAN FRANCISCO

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1. BACKGROUND

The basins of Sunnydale and Yosemite occupy 986 acres and 1,469 acres, respectively, in the southeast quadrant of the City and County of San Francisco. Current NPDES permit requirements dictate a combined sewer overflow (CSO) reduction in each of the two basins from the existing level of about 46 per year to one per year, on the average. The Bayside Facilities Plan, prepared by Caldwell-Gonzalez-Kennedy and Tudor Engineers in 1982, describes the apparent best alternative for achieving this goal. In the recommended solutions, each of the two basins would have its own wet weather facilities to intercept, store and transfer combined flows to the SEWPCP for treatment. Sunnydale flows would be routed to the SEWPCP via the Yosemite System. Each of the two basins would have a storage structure. In addition, Yosemite Basin would have a pump station (Griffith Pump Station) and Sunnydale would be provided with either a lift station or a pump station, depending on the scenario to be selected.

2. PURPOSE

The purpose of this investigation is to evaluate two basic scenarios, the first with a gravity Sunnydale scheme, similar to that described in the Bayside Facilities Plan, and the second with a pump-dependent Sunnydale system. Also, the best apparent scenario is to be identified and corresponding facility sizes recommended.

3. BASIC SCENARIOS

The two basic scenarios stem from the manner in which future Sunnydale Facilities will interact with the Yosemite System. The first scenario uses a gravity-dependent Sunnydale System and is conceptually similar to the apparent best alternative described in the Bayside Facilities Plan. The second scenario depends on pumping as the primary means of transferring flows to the Yosemite System. A description of these two basic scenarios and their interface with the Yosemite System is given below.

3a. Gravity-Dependent Sunnydale Scenario

A schematic representation of a gravity-dependent Sunnydale System is shown in Figure 1, Part A. The gravity-dependent system has the following major physical and operational features.

- Off-line storage and lift station in Sunnydale.
- Second chamber in Yosemite-Fitch Transport/Storage, dedicated to the transport of Sunnydale flows to the Griffith Pump Station.
- The Griffith Pump Station, rated at 120 million gallons per day (mgd), has two separate 60 mgd sumps, each dedicated to flows from Sunnydale and Yosemite, respectively.
- No hydraulic interaction between Sunnydale Facilities and Yosemite Transport/Storage Structure(s).
- This scenario, given the proper hydraulic control structures, is adapatable, within limits, to both coastline facilities as well as upstream facilities.
- Flow up to 60 mgd can be diverted by gravity from Sunnydale to Griffith Pump Station via the Candlestick Tunnel and the second chamber in the Yosemite-Fitch Transport/Storage Structure. Sunnydale flow in excess of 60 mgd will be stored in the Sunnydale Reservoir.
- When flow in the Sunnydale watershed falls below 60 mgd, i.e., the capacity of the gravity conduits to Griffith Pump Station, the Sunnydale lift station dewaters the Sunnydale Reservoir into the Sunnydale sewer to maintain the 60 mgd gravity flow to Griffith Pump Station. Partial recirculation of pumped flows is expected.

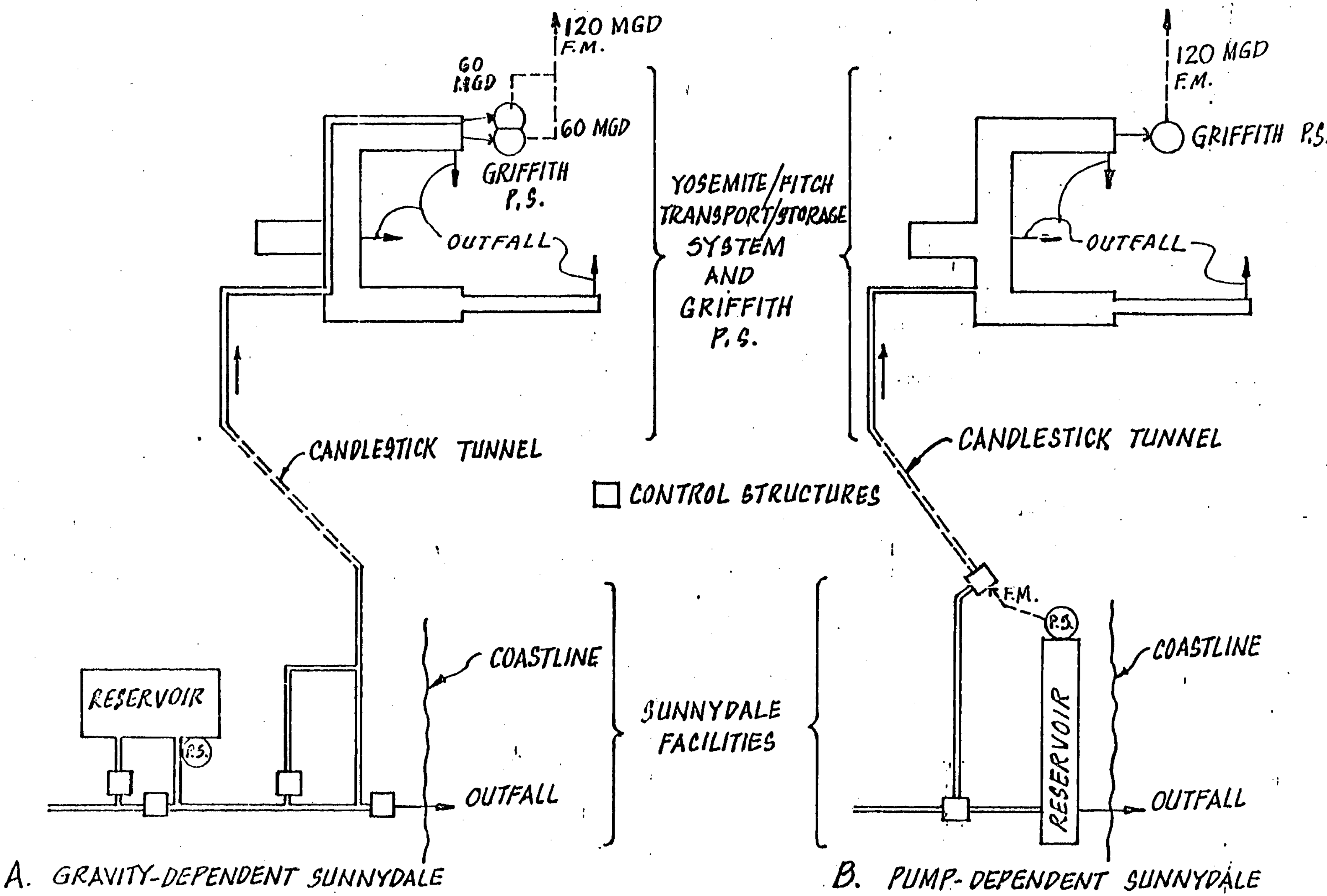

FIGURE 1. SUNNYDALE AND YOSEMITE FACILITIES. SCHEMATIC REPRESENTATION OF TWO BASIC SCENARIOS

- The gravity nature of this scenario restricts the transfer of flows from Sunnydale to the Griffith Pump Station to a maximum of 60 mgd, the hydraulic capacity of the system (Candlestick tunnel) under gravity flow conditions. As will be shown later, pumping less than 60 mgd from Sunnydale results in larger overall storage requirements. This, therefore, limits the plausible storage-pump choices to one.

3b. Pump-Dependent Sunnydale Scenario

A typical case of a pump-dependent Sunnydale System is depicted in the schematic shown in Part B of Figure 1. The main physical and operational features of such a system are summarized below.

- Off-line Sunnydale storage and pump station with force main discharging into a control structure at the upstream portal of the Candlestick tunnel.

- No second chamber in the Yosmite-Fitch Transport/Storage structure. Flows from Sunnydale are discharged directly into this structure to combine with indigenous Yosemite flows.

- Maximum gravity flow, 60 mgd, from Sunnydale to Yosemite-Fitch is possible only when the storage level in the latter is below elevation -18 feet. As the water level in Yosemite-Fitch rises above -18 feet, gravity flow from Sunnydale decreases. In either case, excess Sunnydale flow will be diverted into the Sunnydale storage. When Sunnydale storage reaches a predetermined level, the Sunnydale pumps will come on line to pump flow via a force main into the control structure at the upstream portal of Candlestick Tunnel. A flap gate in the control structure will close as a result of the downstream hydrostatic pressure created by the pumped flow, thus forcing the entire flow in the Sunnydale sewer into the Sunnydale Storage Facility.

- The Griffith Pump Station operates as one unit to pump flows emanating from the Yosemite Storage Facilities to the SEWPCP at the maximum possible pumping rates until the Yosemite Storage is emply. This scenario maximizes the use of Griffith Pump Station and results in 1.9 million gallons less storage requirements in Yosemite.

- The dependence of this scenario on pumping instead of gravity has the advantage of allowing more flexibility in the selection and evaluation of pumping-storage combinations. Also, it frees the Candlestick Tunnel and the space that would have otherwise been occupied by the second chamber in Yosemite-Fitch, to be used as part of the Yosemite Storage requirements. This amounts to an available storage of about 1.7 million gallons.

- Since most of the wet weather flow in Sunnydale will be collected by the transport/storage facility prior to pumping into the Yosemite System, it is obvious that this scenario is best served by a storage-pump system located as close to the downstream boundary of the Sunnydale Basin as possible.

4. <u>BASIC DATA</u>

The comparison between the two scenarios described above was based on facility sizes determined by using the same basic data to develop the required information. In both cases, the following input data was utilized.

- 70 years (1907-1977) of hourly rainfall data.

- Catchment areas.

a.	Sunnydale:	986 acres
b.	Yosemite:	1469 acres

- Runoff Coefficients:
  - a. Sunnydale: 0.6
  - b. Yosemite: 0.6
- Griffith Pump Station: 120 mgd

In addition, the same criterion was applied in determining the number of overflows in each of the two areas. Under the adopted definition, overflow events are separated by a minimum of six consecutive hours during which no overflow takes place.

5. ALTERNATIVES ANALYZED

Based on the two scenarios defined earlier, the following alternatives were analyzed, all with a 120 mgd Griffith Pump Station.

1. Gravity-Dependent Sunnydale System

a.	Sunnydale Withdrawal Rate: Yosemite Withdrawal Rate:	60 mgd maximum 60 mgd maximum

2. Pump-Dependent Sunnydale System

a.	Sunnydale Withdrawal Rate: Yosemite Withdrawal Rate:	45 mgd maximum 120 mgd less flow from Sunnydale
b.	Sunnydale Withdrawal Rate: Yosemite Withdrawal Rate:	60 mgd maximum 120 mgd less flow from Sunnydale
c.	Sunnydale Withdrawal Rate: Yosemite Withdrawal Rate:	75 mgd maximum 120 mgd less flow from Sunnydale
d.	Sunnydale Withdrawal Rate: Yosemite Withdrawal Rate:	90 mgd maximum 120 mgd less flow from Sunnydale

It is obvious from the alternatives described above that a pump-dependent Sunnydale scheme offers a high flexibility in choosing among pumping alternatives. On the other hand, the gravity-dependent Sunnydale scenario is limited by the 60 mgd hydraulic capacity of the conveyance system to Griffith Pump Station. Pumping less than 60 mgd from Sunnydale is possible but not desirable since, as will be shown later, it is not the optimum pumping rate that will minimize storage requirements with the Sunnydale runoff coefficient at 0.6.

6. METHOD OF ANALYSIS

The analysis of the alternatives described in the preceding section was based on both manual calculations and a hydrologic computer model, depending on the relative magnitude of pumping versus storage. Specifically, manual calculations were performed for Sunnydale pumping rates of 75 mgd and 90 mgd, respectively.

Repeated application of the computer model, using the withdrawal rate-storage volume parameters for the various alternatives described in Section 5, generated the information needed to plot trade-off curves showing the relationship of storage versus pumping. Trade-off curves are presented and discussed in subsequent sections.

7. DISCUSSION AND COMPARISON OF RESULTS

7a. Gravity-Dependent Sunnydale

A gravity-dependent Sunnydale System will not impact the Yosemite System and was, therefore, evaluated independently using a maximum withdrawal rate of 60 mgd, the hydraulic capacity of the downstream conduits (Candlestick tunnel) under gravity flow conditions. Part A of Figure 2 is a trade-off curve showing the Sunnydale storage required to reduce overflows to the values indicated on the vertical axis of the graph. To achieve the one overflow per year requirement, storage capacity of about 7.5 million gallons (MG) must be provided in the Sunnydale basin.

For the sake of completeness, a similar trade-off curve for the Yosemite System is shown in Part B of Figure 2. Although the Griffith Pump Station will have a capacity of 120 mgd, the net withdrawal rate from Yosemite Storage under this scenario will be 60 mgd. Interpretation of the Yosemite trade-off curve is similar to, but independent from that of Sunnydale. To reduce overflows in Yosemite to one per year, on the average, 16 MG of storage capacity is required (see Part 1 of Table 1), of which 1 MG is storage in existing sewers.

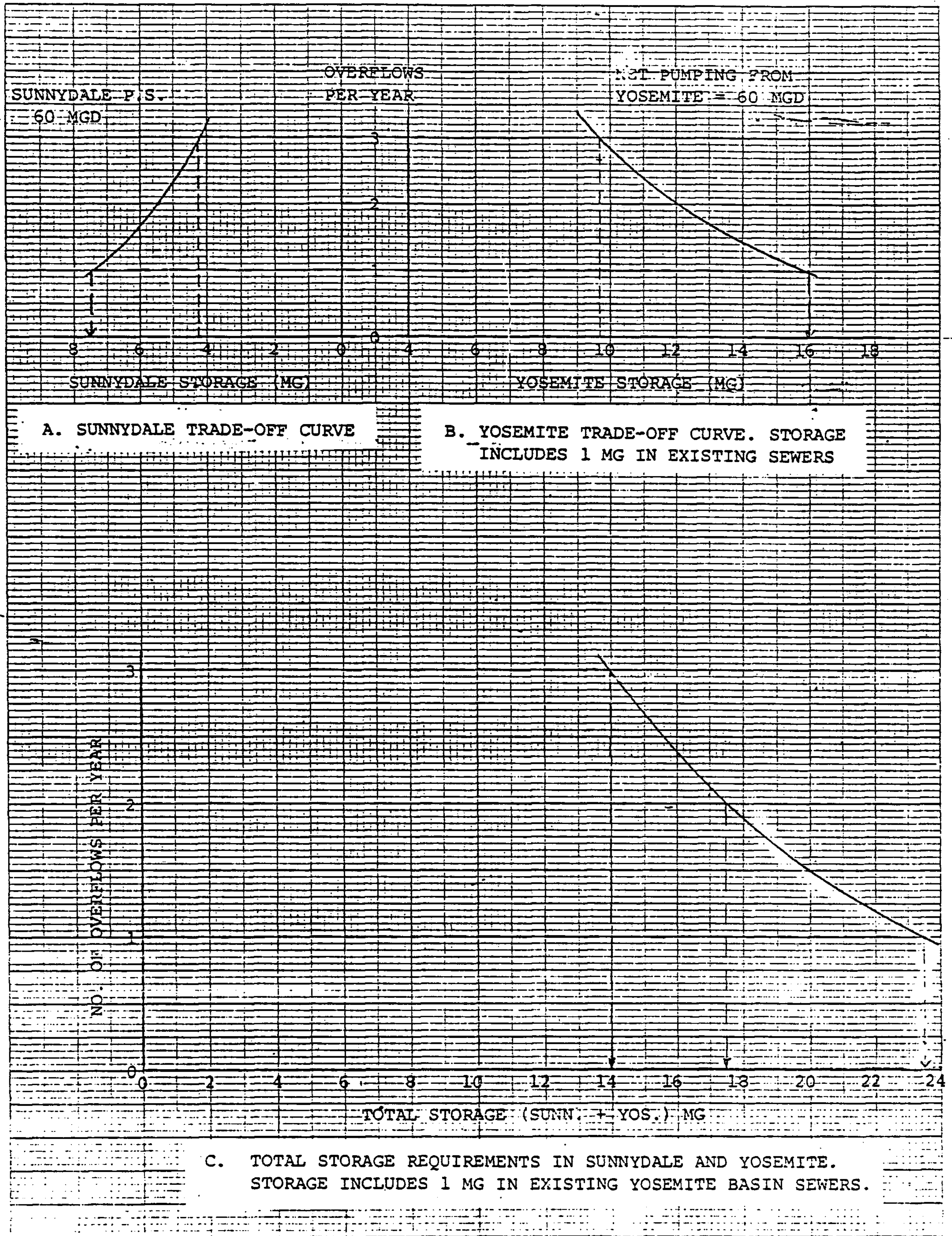

Figure 2. Sunnydale-Yosemite Trade-Off Curves Based on a Gravity-Dependent Sunnydale System.

Table 1. Sunnydale and Yosemite Facilities. Comparison of Gravity versus Pump-Dependent Sunnydale Scenarios. Griffith P.S. set at 120 mgd in All Cases.

			Description	Storage (MG)	
1.	Gravity - Dependent Sunnydale				
	a.	60 mgd Sunnydale P.S.			
		(i)	Sunnydale Storage Required	7.5	(+)
		(ii)	Yosemite Sotrage Required	16.0 *	(+)
			Available Storage	0	(-)
		(iii)	Total Storage Required	23.5 *	
2.	Pump - Dependent Sunnydale				
	a.	45 mgd Sunnydale P.S.			
		(i)	Sunnydale Storage Required	9.8	(+)
		(ii)	Yosemite Storage Required	12.8	(+)
			Available Storage	1.7	(-)
			Existing Sewer Storage	1.0	(-)
		(iii)	Total Additional Storage Required	$\boxed{19.9}$	
	b.	60 mgd Sunnydale P.S.			
		(i)	Sunnydale Storage	7.5	(+)
		(ii)	Yosemite Storage	14.1	(+)
			Available Storage	1.7	(-)
			Existing Sewer Storage	1.0	(-)
		(iii)	Total Additional Storage Required	$\boxed{18.9}$	
	c.	75 mgd Sunnydale P.S.			
		(i)	Sunnydale Storage	6.3	(+)
		(ii)	Yosemite Storage	16.1	(+)
			Available Storage	1.7	(-)
			Existing Sewer Storage	1.0	(-)
		(iii)	Total Additional Storage Required	$\boxed{19.7}$	
	d.	90 mgd Sunnydale P.S.			
		(i)	Sunnydale Storage	5.5	(+)
		(ii)	Yosemite Storage	18.1	(+)
			Available Storage	1.7	(-)
			Existing Sewer Storage	1.0	(-)
		(iii)	Total Additional Storage Required	$\boxed{20.9}$	

*Includes 1 MG of storage in existing Yosemite sewers

Part C of Figure 2 is a conjunctive trade-off curve combining the Sunnydale and Yosemite storage requirements.

7b. Pump-Dependent Sunnydale

The heavy dependence of this scenario on pumping as the primary means of removing flows from the Sunnydale basin, introduces a second dimension in the method of analysis. Specifically, the consideration of alternative withdrawal rates from both Sunnydale and Yosemite, as compared to the previous scenario which is limited to a single rate, vis a vis 60 mgd from each of the two basins. The various pumping combinations are described in Section 5.

Trade-off curves for Sunnydale and Yosemite are shown in Figure 3, Parts A and B. Each curve in Part A (Sunnydale) has its counterpart curve in Part B (Yosemite) since, under this scenario, the size of the Sunnydale Facilities has a direct impact on the size of the Yosemite facilities. Interpretation of Parts A and B of Figure 3 is similar to that of Parts A and B of Figure 2 described in Section 6a. However, in the case of the pump-dependent Sunnydale system discussed here, the Yosemite storage requirements include 1.7 MG of 'bonus' storage inherent in a pump-dependent versus a gravity-dependent Sunnydale scenario (see explanation in Section 3b). Storage requirements in Sunnydale and Yosemite are shown in Part 2 of Table 1.

Part C of Figure 3 shows the total additional storage requirements for Sunnydale and Yosemite combined. The graph is self-explanatory and may be used in conjunction with pump station and storage facility costs to determine the least expensive storage-pumping combination. The curves in Part C of Figure 3 indicate that a 60 mgd Sunnydale pump station will minimize the overall volume of storage required. A 60 mgd Sunnydale pump station is associated with 7.5 MG of Sunnydale storage and 14.1 MG of Yosemite storage. The numbers encased in rectangles in Table 1, Part 2 denote the total additional storage volume requirements in Sunnydale and Yosemite under the various Sunnydale pump alternatives.

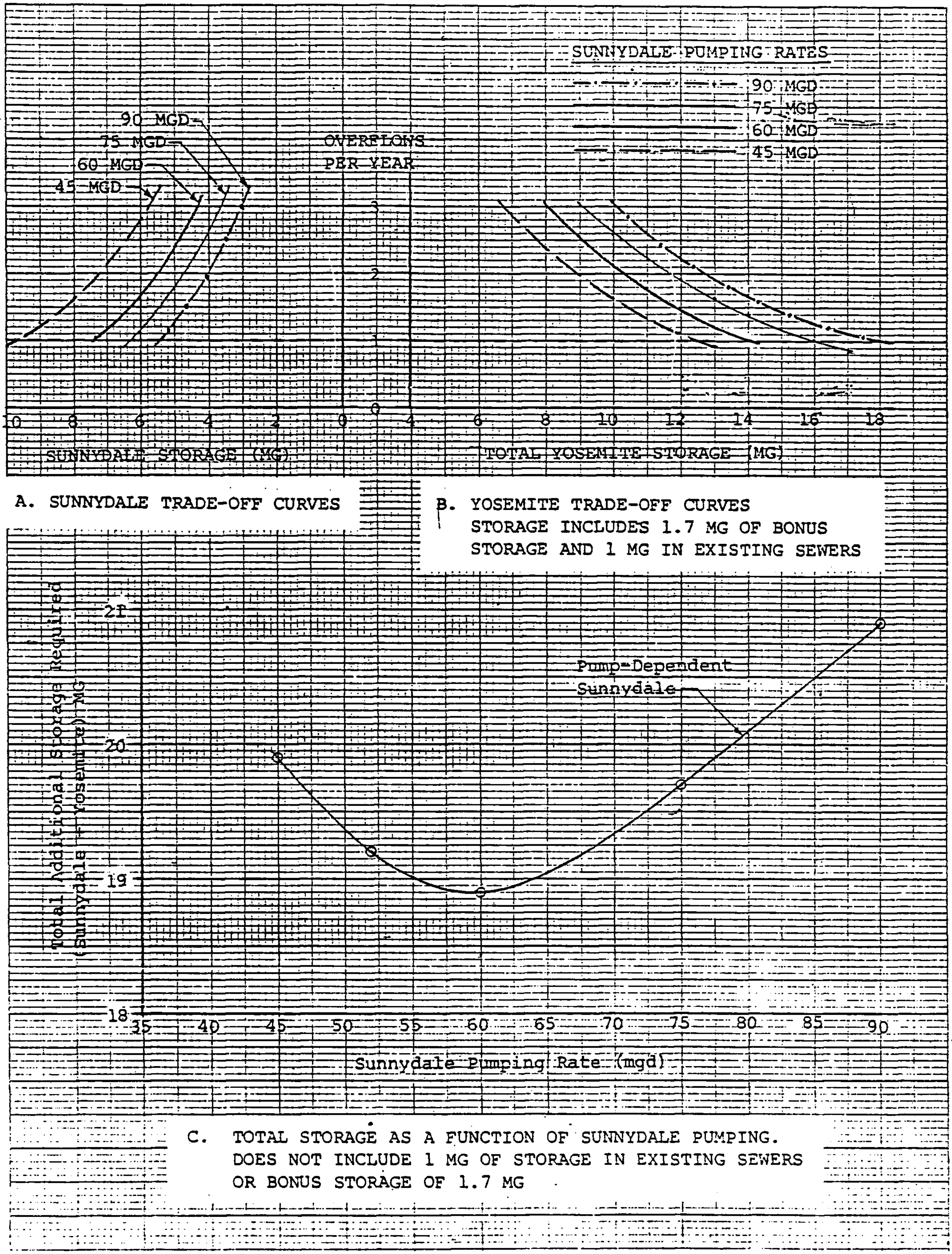

Figure 3. Sunnydale-Yosemite Trade-Off Curves Based on a Pump-Dependent Sunnydale System and 120 mgd Griffith Pump Station.

7c. Volumes Pumped

The purpose of this section is to provide the engineer with estimates of pumped volumes to be used in energy cost determinations in relation to the Sunnydale System scenarios and alternatives. Determination of other energy-related items such as total dynamic head and demand charges were not addressed.

The average yearly volumes that will be pumped under the various scenarios/alternatives are noted below.

- In a gravity-dependent Sunnydale system with a 60 mgd lift station, approximately 40 MG of sewage per year must be removed. However, the total volume to be actually pumped is about 90 MG, due to partial recirculation of pumped flows depending on the Sunnydale watershed flow at the time.

- In the case of a pump-dependent Sunnydale system, the following volumes should be used.

Sunnydale Pump Station	Volume Pumped
45 mgd	205 mg/year
60 mgd	150 mg/year
75 mgd	150 mg/year
90 mgd	150 mg/year

8. CONCLUSIONS AND RECOMMENDATIONS

The conclusions listed below emanate from the results presented and discussed in Section 7. These conclusions concern only facility sizes under the two scenarios and alternatives therein that will achieve the required overflow reduction. Issues such as cost, environmental impact, public acceptability, etc., are not reflected in the conclusions. However, the results of this analysis will provide the basis for determining the most cost-effective alternative.

8a. Conclusions

- o A pump-dependent Sunnydale system will minimize total and net additional storage requirements in Yosemite and save the construction cost of a second chamber in the Yosemite-Fitch transport/storage structure.

- o Considering the two scenarios evaluated and the basic data utilized, a 60 mgd Sunnydale pump station, together with a 120 mgd Griffith Pump Station, will minimize overall storage requirements, if a pump-dependent Sunnydale system were to be adopted.

- o A gravity-dependent Sunnydale system minimizes the volume of sewage to be pumped by the Sunnydale Pump Station. However, pumping cost savings may be insignificant.

8b. Recommendations

The recommendations that follow relate only to the selection of a pump-dependent versus a gravity-dependent scenario.

- o Use the pump-dependent Sunnydale Scenario.

- o Based upon the total storage required to reduce overflows to one per year, under a pump-dependent Sunnydale scheme, the following would be recommended.

Description	Sunnydale	Yosemite
Storage (MG)	7.5	14.1
Pump Station (mgd)	60	120

- o For the overflow level, i.e., one overflow per year, to be adopted, use the data in Section 7 to establish pump station and storage facility costs for the various alternatives. Use to confirm the cost-effectiveness of the facility sizes recommended above.

- Use the volumes given in Section 7c to estimate Sunnydale pumping costs: Incorporate these costs in the overall cost analysis.

- Establish an updated runoff coefficient for the Sunnydale area and continue the analysis considering the effect of present versus future runoff factors.

APPENDIX B

SUNNYDALE-YOSEMITE CSO PROJECTS

REVISED FACILITY SIZES BASED ON PRESENT

AND ULTIMATE SUNNYDALE DEVELOPMENT

JUNE, 1985

by

C. A. Phanartzis

HYDROCONSULT ENGINEERS

for

CLEAN WATER PROGRAM

CITY AND COUNTY OF SAN FRANCISCO

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1. BACKGROUND

The basins of Sunnydale and Yosemite occupy 986 acres and 1,469 acres, respectively, in the southeast quadrant of the City and County of San Francisco. Current NPDES permit requirements dictate a combined sewer overflow (CSO) reduction in each of the two basins from the existing level of about 46 per year to one per year, on the average. The Bayside Facilities Plan[1] describes apparent best alternative for achieving this goal. In the recommended solutions, each of the two basins would have its own wet weather facilities to intercept, store and transfer combined flows to the SEWPCP for treatment. Sunnydale flows would be routed by gravity to the Griffith Pump Station via a dedicated conduit. Each of the two areas would have a storage structure. In addition, Yosemite Basin would have a pump station (Griffith Pump Station) and Sunnydale would be provided with either a lift station or a pump station.

A recent evaluation[2] has shown that a pump-dependent Sunnydale system, as compared to a gravity system, will reduce the storage requirements in Yosemite, resulting in substantial savings in construction costs. As a result, a pump-dependent system was recommended.

All hydrological studies associated with the sizing of the Sunnydale and Yosemite facilities were based on the assumption of full development in the respective watersheds, corresponding to a runoff coefficient of 0.6 in both areas. This is valid for the Yosemite Basin both under current and ultimate conditions. However, because of the relatively large park area in Sunnydale, a runoff coefficient of 0.6 appears high even under ultimate development

[1] Bayside Facilities Plan, SE Bayside Project Report, March 1982.
[2] Sunnydale-Yosemite CSO Projects Gravity Versus Pumping Sunnydale System, May, 1985.

conditions. As a result, it was decided to conduct a detailed survey to update the current Sunnydale runoff coefficient and to establish a coefficient for ultimate conditions.

2. PURPOSE

The purpose is to revise the hydrologic analysis in Sunnydale and Yosemite using the updated Sunnydale runoff coefficients and to recommend changes, if any, in facilities sizes and operation to achieve the required overflow reduction under both current and ultimate Sunnydale development conditions.

3. SYSTEM DESCRIPTION

The Sunnydale-Yosemite System evaluated in this study provides for a pump-dependent Sunnydale scheme as per recommendations in a recent report (see footnote 2 on preceding page). A schematic representation of the system is shown in Figure 1. The main physical and operational features are summarized below.

- In-line or off-line Sunnydale storage and pump station with force main discharging into a control structure at the upstream portal of the Candlestick Tunnel.

- In-line storage in Yosemite area in the form of a transport/storage facility, identified as Yosemite-Fitch transport/storage structure. A 66" diameter line connects the downstream end of Candlestick Tunnel to this structure at the intersection of Armstrong Avenue and Hawes Street.

- Griffith Pump Station, 120 mgd nominal, located at the downstream end of Yosemite-Fitch transport/storage structure, with force main discharging into a control structure at the upstream end of Hunters Point Tunnel.

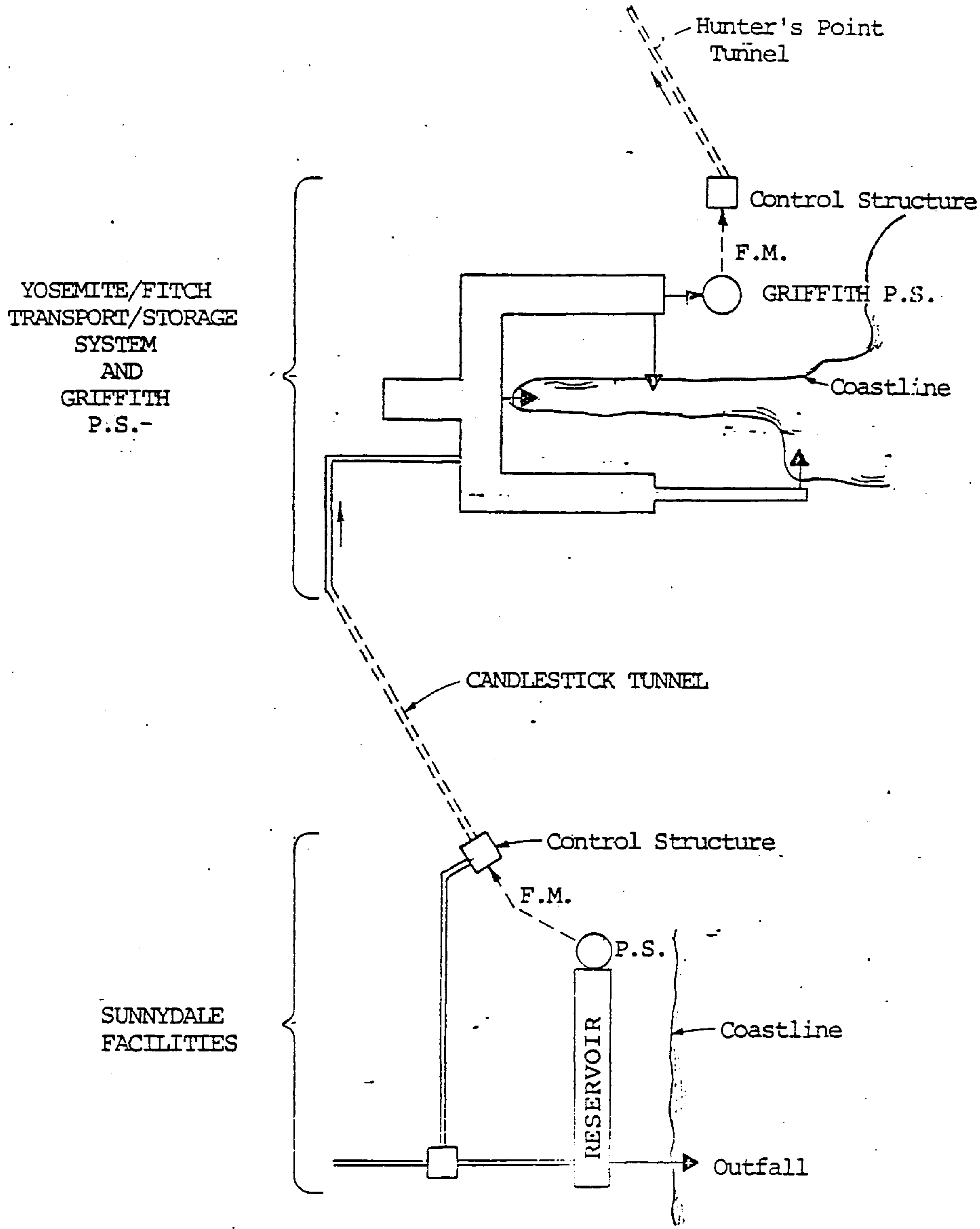


Figure 1. SUNNYDALE AND YOSEMITE FACILITIES.
SCHEMATIC REPRESENTATION

- No second chamber in the Yosemite-Fitch Transport/Storage structure. Flows from Sunnydale are discharged directly into this structure to combine with indigenous Yosemite flows.

- The Griffith Pump Station operates as one unit to pump flows emanating from the Yosemite Storage Facilities to the SEWPCP at the maximum possible pumping rates until the Yosemite Storage is empty. In contrast with the gravity Sunnydale System, this scheme maximizes the use of Griffith Pump Station and results in lower storage requirements in Yosemite.

- Maximum gravity flow, 60 mgd, from Sunnydale to Yosemite-Fitch is possible only when the storage level in the latter is below elevation -18 feet. As the water level in Yosemite-Fitch rises above -18 feet, gravity flow from Sunnydale decreases. In either case, excess Sunnydale flow will be diverted into the Sunnydale storage. When Sunnydale storage reaches a predetermined level, the Sunnydale pumps will come on line to pump flow via a force main into the control structure at the upstream portal of Candlestick Tunnel. The pumping rate will be selected to be in accord with the Sunnydale runoff coefficient in effect at the time and the alternative to be selected for implementation. A flap gate in the control structure will close as a result of the downstream hydrostatic pressure created by the pumped flow, thus forcing the entire flow in the Sunnydale sewer into the Sunnydale Storage Facility.

4. BASIC DATA

The hydrologic analysis was based on the data used in previous studies except for the Sunnydale runoff coefficients. The current Sunnydale runoff coefficient was revised based on a detailed survey of the Sunnydale watershed. The future value of the runoff coefficient was estimated by projecting ultimate development on an area by area basis depending on land use classification. The results are summarized in Table 1, below.

Table 1. Revised Sunnydale Runoff Coefficients

		Area Classification			
			Unpaved Surfaces		
Description	Paved Surfaces	Resi-dential	Ind. & Coml.	Parks & Play-grounds	Weighted Runoff Coeff.
1. Current Conditions					
Area (Acres)	437	100	99	350	
% Runoff	95	10	15	~~20~~ 10	0.48
2. Ultimate Conditions					
Area (Acres)	490	100	46	350	
% Runoff	95	10	15	10	0.52

The input data used in this investigation is listed below.

- 70 years (1907-1977) of hourly rainfall data
- Catchment areas

  a. Sunnydale: 986 Acres
  b. Yosemite: 1469 Acres

- Runoff Coefficient:

	Present	Ultimate
a. Sunnydale	0.48	0.52
b. Yosemite	0.60	0.60

- Griffith Pump Station 120 mgd

Determination of Sunnydale and Yosemite storage requirements and Sunnydale pumping rates will be the result of this investigation.

The definition of an overflow event is the same as in all previous studies. Overflow events are separated by a minimum of six consecutive hours during which no overflow takes place.

5. METHOD OF ANALYSIS

The analysis was performed with the aid of a computer model and, in some cases, by manual calculations, depending on the relative magnitude of pumping versus storage. In addition to the fixed basic data values described in Section 4, inputs to the model include variable parameter values describing Sunnydale storage, pumping rate and Yosemite Storage.

Repeated application of the computer model using different combinations of variable input values and manipulating these until overflow frequency was reduced to once per year, generated the information needed to plot trade-off curves. These curves are presented and discussed in Section 6.

6. DISCUSSION AND INTERPRETATION OF RESULTS

Three sets of results were developed using the basic data described above. They are shown in the form of trade-off curves in Figure 2. The two curves in each set correspond to the current (solid line) and ultimate (dashed line) Sunnydale runoff coefficients, respectively. All curves show storage requirements as a function of Sunnydale pumping rate. The bottom pair of curves relates to the Sunnydale storage-pumping needs, the middle pair shows the Yosemite storage requirements and the top pair shows the sum of the Sunnydale and Yosemite storage requirements as a function of Sunnydale pumping rates.

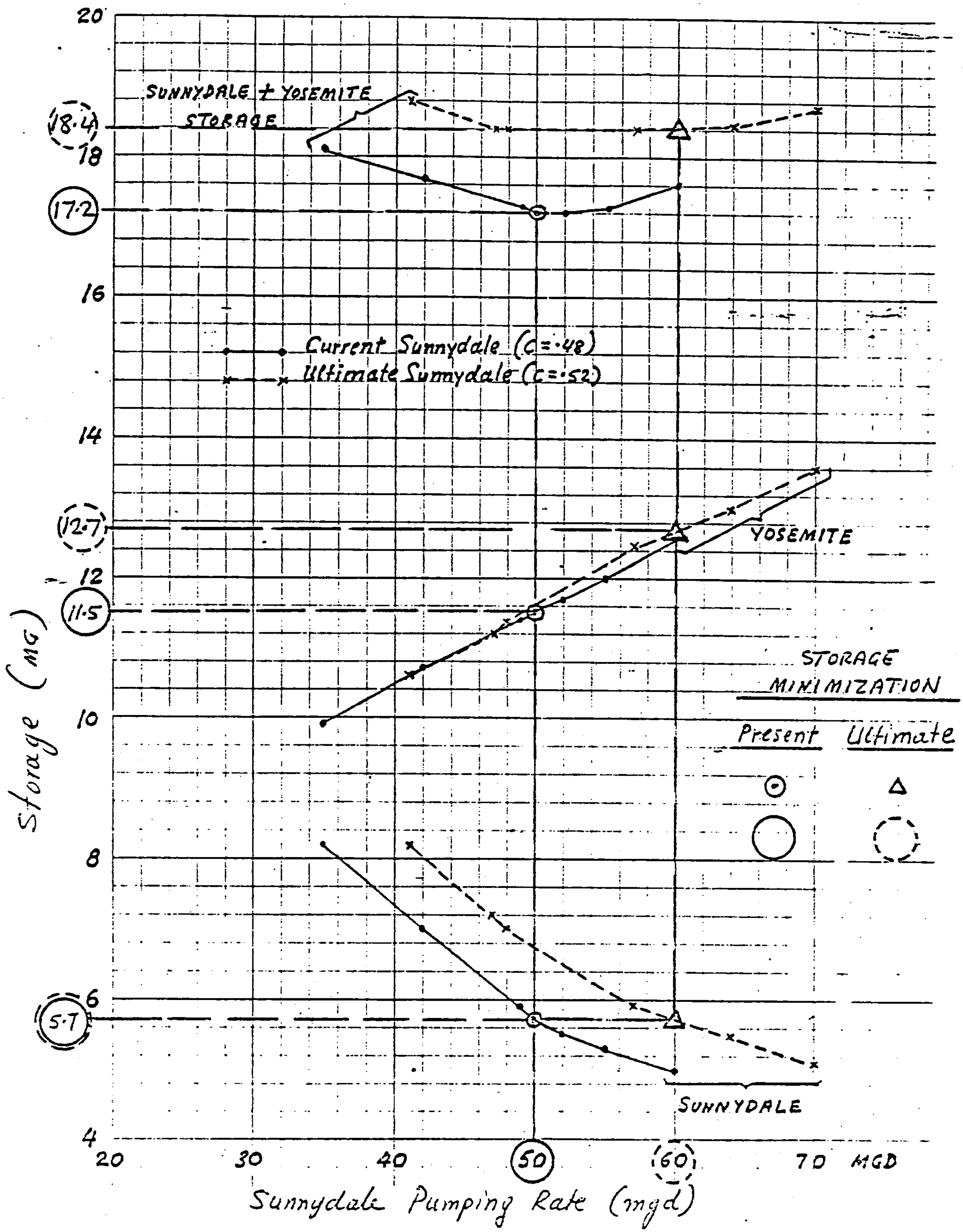


FIGURE 2. SUNNYDALE AND YOSEMITE TRADE-OFF CURVES. STORAGE NEEDS UNDER PRESENT AND ULTIMATE DEVELOPMENT CONDITIONS.

According to the trade-off curves in Figure 2, as the Sunnydale pumping rate increases, Sunnydale storage decreases, whereas Yosemite storage increases. Also, the total storage, shown at the top of Figure 2, experiences its lowest value around the 50-52 mgd Sunnydale pumping rate under current Sunnydale conditions (C=0.48). For ultimate Sunnydale development (C=0.52), the lowest point on the curve covers a wider range of pumping rates, 45 mgd to 60 mgd.

The minimum total storage requirements under current and ultimate Sunnydale development (see top of Figure 2), are 17.2 mg and 18.4 mg, respectively. The ideal solution would be to design the Sunnydale and Yosemite facilities in such a way as to minimize both current and ultimate storage needs. The chart in Figure 3 shows alternative ways to achieve compliance, first under present Sunnydale development and subsequently, under ultimate Sunnydale development conditions, and gives the corresponding storage requirements. The apparent best alternative route is shown by a double line. Reasons for recommending this alternative are listed below.

- It minimizes overall storage requirements under both present (17.2 mg) and ultimate (18.4 mg) development conditions (see Figure 2).

- It provides for a smaller storage structure (5.7 mg) in the Sunnydale area than other alternatives. This is an advantage, since storage facilities in Sunnydale are either more expensive to implement due to property acquisition and existing business relocation costs, or face space limitations, if built on public land.

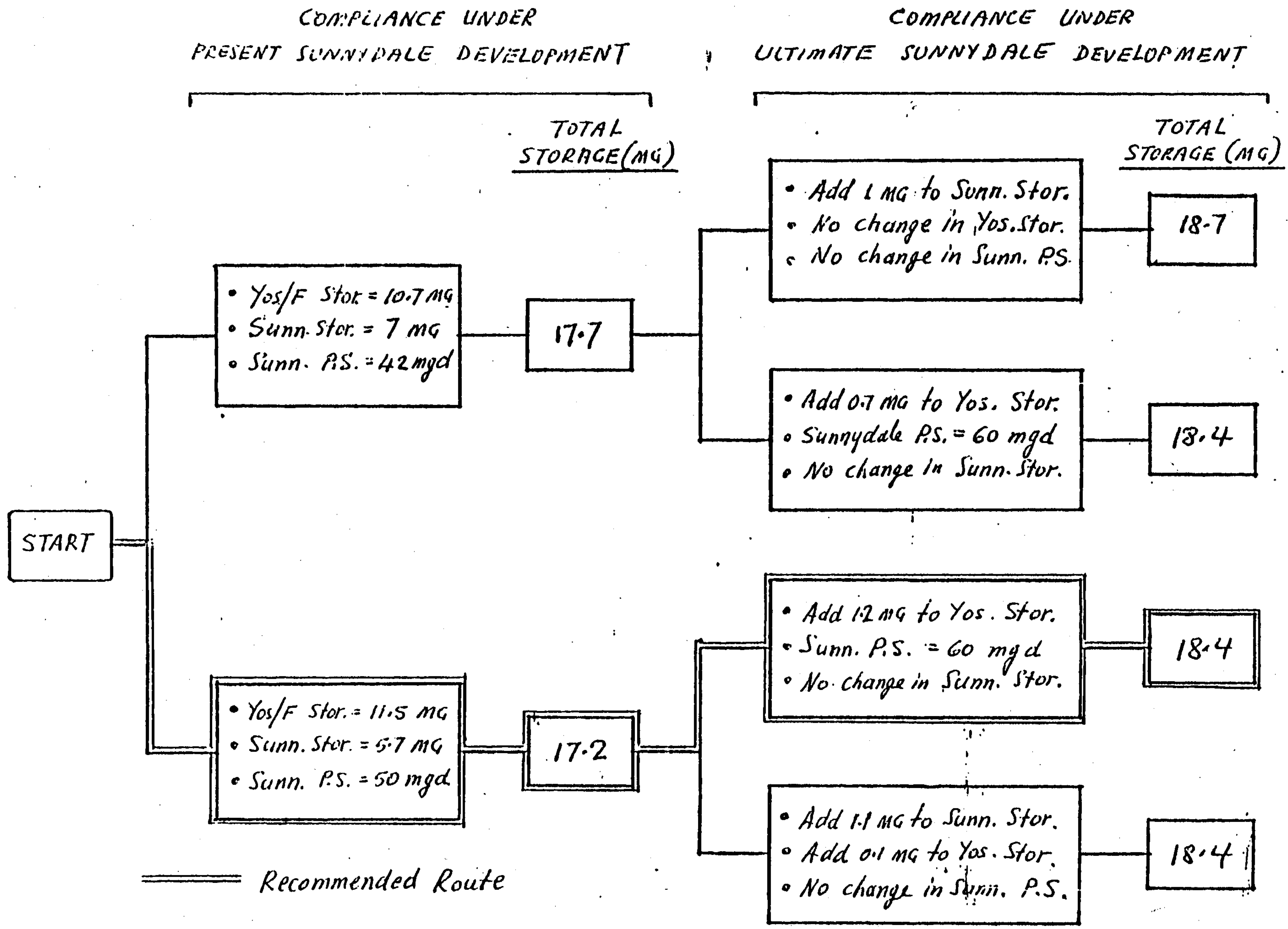


FIGURE 3. SUNNYDALE – YOSEMITE FACILITIES. ALTERNATIVE WAYS TO ACHIEVE COMPLIANCE UNDER PRESENT AND ULTIMATE DEVELOPMENT CONDITIONS

- The additional storage (1.2 mg) needed to achieve compliance under ultimate conditions will be built in the Yosemite area, an advantage over Sunnydale for the reasons described in the preceding paragraph.

- Building the additional future storage in Yosemite can be combined with the construction of Shafter outfall, should one be required, in the form of a dual purpose structure. This is a very cost-effective way to solve the problem of additional storage and a new outfall.

7. CONCLUSIONS

- The revised current and expected ultimate Sunnydale runoff coefficients are 0.48 and 0.52, respectively, as compared to 0.6, the value used in previous studies.

- The lower runoff Coefficients in Sunnydale will result in lower overall storage requirements.

- If Sunnydale area development reaches ultimate conditions, additional storage volume must be provided to maintain overflow compliance.

- Construction of the Shafter outfall in the future, should one be required, must be combined with the building of the additional future storage. Present facilities should, therefore, be sized accordingly.

8. RECOMMENDATIONS

Based on the criterion of storage minimization under both present and ultimate development conditions, the following is recommended.

A. Present Development Conditions

- o Build 5.7 mg of storage in Sunnydale. Also, construct Sunnydale Pump Station at 50 mgd, upgradable to 60 mgd in the future.

- o Provide 11.5 mg of storage in Yosemite-Fitch. Of this, 2.0 mg is available in Candlestick tunnel and the existing Yosemite area sewers. Therefore, a net storage of 9.5 mg must be built. The current Yosemite-Fitch design is for 8.7 mg, of which 0.7 mg corresponds to the volume of the omitted second compartment in the Yosemite-Fitch transport/storage structure. Provide the balance of 0.8 mg of storage by substituting an 18 foot box for the 96" pipe on Bancroft Street between Fitch and Griffith Streets.

- o Build Griffith Pump Station at 120 mgd, nominal capacity.

B. Ultimate Development Conditions

- o Add 1.2 mg of storage to the Yosemite area facilities. Combine the additional storage with the construction of Shafter Outfall, should one be required at that time.

- o Upgrade Sunnydale pump station to 60 mgd.

Annex II

ANNEX II

SAN FRANCISCO CLEAN WATER PROGRAM

City and County of San Francisco Mailing Address: P.O. Box 360, San Francisco, California 94101

770 Golden Gate Avenue
(415) 558-2131

100 Van Ness Avenue
(415) 431-9430

September 25, 1984

Combined Sewer Overflows
Project Priority

2.2.11.1/P-37

Ms. Judith Ayers
Regional Administrator
Environmental Protection Agency, Region IX
215 Fremont Street
San Francisco, CA 95105

Mr. Jesse Diaz, Chief
Division of Water Quality
State Water Resources Control Board
P.O. Box 100
Sacramento, CA 95801

Mr. Roger James
Executive Officer
Regional Water Quality Control Board
1111 Jackson Street, Room 6040
Oakland, CA 94607

Dear Ms. Ayers and Messrs. Diaz and James:

As you know, the City of San Francisco has initiated its program for control of combined sewer overflows (CSO) in the Southeast area of the City and has filed a grant application to construct various of the required facilities. Our efforts to date have been prioritized in such a fashion that we would achieve control in India Basin, then Yosemite Basin followed by South Basin. Our Program, as reflected in our CSO Application, envisions three phases of work. The project phases, priority and designations are shown on Attachment A.

As we have progressed through design, it has become apparent that a revision to the implementation sequence would achieve greater environmental benefit at an earlier date for the same overall cost. The proposed change in priority envisions construction of the Sunnydale Outfalls Consolidation in Phase I. The Griffith Reservoir and Shafter Avenue Outfall to be shifted to Phase II.

Table 9-1 in Attachment B shows the improvements achieved as each of the elements of the first two phases is constructed. Table 9-1 Revised demonstrates the improvements that can be achieved by constructing Sunnydale Facilities ahead of the Griffith Reservoir. It should be noted that for approximately the same expenditure level at the completion of Segment #4, the revised priority would bring South Basin into compliance (one overflow per year) and Yosemite Basin would be near compliance with slightly over three overflows per year. This contrasts markedly with the original priority which would have Yosemite in compliance and South Basin uncontrolled at an overflow frequency of 43 per year.

Because we believe the revised priority is quite superior, we have already contacted various community organizations and leaders regarding this issue. They have been unanimous in their support for this revision. Discussions also have taken place with staff members of EPA Region IX, SWRCB and RWQCB. They also agree that the priority revision is appropriate. Because of the obvious benefits, we are requesting that you formally endorse the priority revision. At the appropriate time, following your collective endorsement, we will make the required changes in our CSO Application.

I would like to express my appreciation to each of the involved agencies and staff members that have assisted us in our efforts in obtaining the CSO Grant.

RECOMMENDED BY:

Louis A. Vagadori, Chief
Project Mgmt. & Coord.

Very truly yours,

Donald J. Birrer 2644
Executive Director

Attachments: As noted.

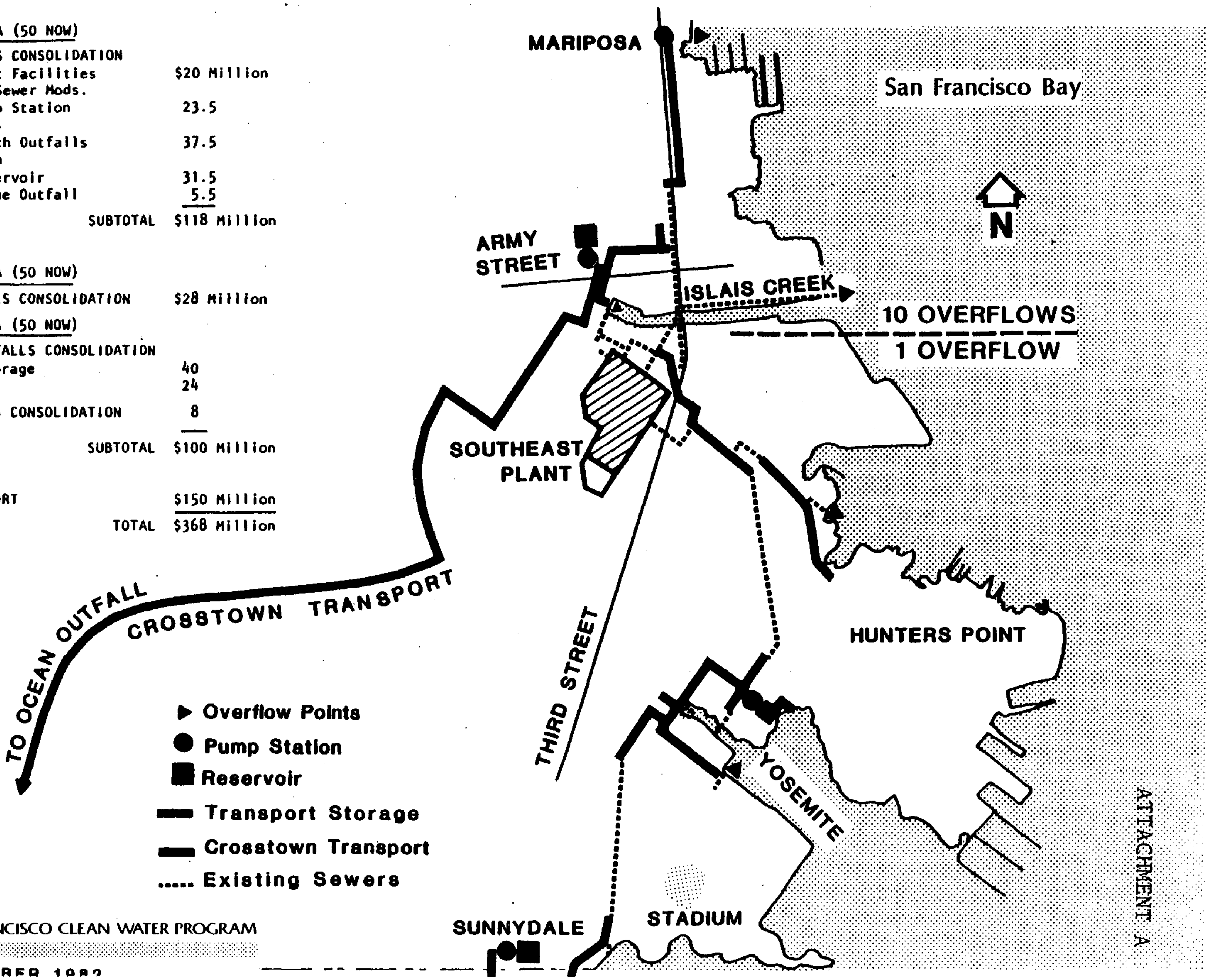
bcc: J. Lee, Director DPW &CWP
T. Landers, CWP
L. Vagadori, CWP
G. White, CWP
H. Coffee, CWP
R. Carlson, CWP
E. Gerulat, CWP
R. Kenealey, City Attny.
J. Roddy, City Attny.
Records Center

All above with attachments.

~~HCC:nl~~

SOUTHEAST AREA SYSTEM

PHASE I	
ONE OVERFLOW AREA (50 NOW)	
YOSEMITE OUTFALLS CONSOLIDATION	
• Hunters Point Facilities & Southeast Sewer Mods.	$20 Million
• Griffith Pump Station & Force Mains	23.5
• Yosemite-Fitch Outfalls Consolidation	37.5
• Griffith Reservoir	31.5
• Shafter Avenue Outfall	5.5
SUBTOTAL	$118 Million
PHASE II	
ONE OVERFLOW AREA (50 NOW)	
SUNNYDALE OUTFALLS CONSOLIDATION	$28 Million
TEN OVERFLOW AREA (50 NOW)	
ISLAIS CREEK OUTFALLS CONSOLIDATION	
• Transport Storage	40
• Pump Station	24
MARIPOSA OUTFALLS CONSOLIDATION	8
SUBTOTAL	$100 Million
PHASE III	
CROSSTOWN TRANSPORT	$150 Million
TOTAL	$368 Million



ATTACHMENT A

SAN FRANCISCO CLEAN WATER PROGRAM

DECEMBER 1982

TABLE 9-1 COMBINED SEWEP OVERFLOW CHARACTERISTICS AND IMPROVEMENTS IN SOUTHEAST AREA

SEWPCP TR. RATE-MGD	Phased Segment Improvements	Yosemite			Hunter's Point			Sunnydale			Islais Creek			Mariposa		
		No.	Duration hr	Volume Mgal	No.	Duration hr	Volume Mgal	No.	Duration hr	Volume Mgal	No.	Duration hr	Volume Mgal	No.	Duration hr	Volume Mgal
140	Existing (as of 6/83)	46	235	370	46	230	87	43	173	188	38	308	1671	45	291	71
	Phase I															
210	1. Hunter's Point Facilities & SE Sewer Mods.	46 (0)	235 (0)	370 (0)	1 (98)	1 (100)	1 (99)	43 (0)	173 (0)	188 (0)	25 (34)	102 (67)	857 (49)	45 (0)	291 (0)	71 (0)
210	2. Griffith P.S. (120 MGD) and Force Mains	31 (33)	196 (17)	185 (50)	1	1	1	43	173	188	26 (32)	117 (62)	983 (41)	45	291	71
210	3. Yosemite/Fitch Outfalls	1 (98)	1.6 (99)	4.4 (99)	1	1	1	43	173	188	26 (32)	137 (56)	1152 (31)	45	291	71
210	4. Griffith Reservoir	0.2 (100)	0.3 (100)	1.0 (100)	1	1	1	43	173	188	26 (32)	137 (56)	1154 (31)	45	291	71
210	5. Shafter Ave Outfall	ALL SAME AS FOR ELEMENT 4														
	Phase II															
210	6. Sunnydale Facilities	1 (98)	2.5 (99)	5.8 (98)	1	1	1	1 (98)	1.8 (99)	3.2 (98)	26 (32)	166 (46)	1254 (25)	45	291	71
320	7. Islais Creek Facilities	1	2.5	5.8	1	1	1	1	1.8	3.2	9.8 (74)	37 (88)	359 (79)	45	291	71
320	8. Mariposa Facilities	1	2.5	5.8	1	1	1	1	1.8	3.2	10 (74)	39 (87)	369 (78)	9.2 (80)	35 (88)	13 (82)

Note: Numbers in parentheses denote, in percent, decreases in the respective overflow parameters.

TABLE 9-1 REVISED COMBINED SEWER OVERFLOW CHARACTERISTICS AND IMPROVEMENTS IN SOUTHEAST AREA

SEWPCP TR. RATE-MGD	Phased Segment Improvements	Yosemite			Hunter's Point			Sunnydale			Islais Creek			Mariposa		
		No.	Duration hr	Volume Mgal	No.	Duration hr	Volume Mgal	No.	Duration hr	Volume Mgal	No.	Duration hr	Volume Mgal	No.	Duration hr	Volume Mgal
140	Existing (as of 6/83)	46	235	370	46	230	87	43	173	188	38	308	1671	45	291	71
	Phase I															
210	1. Hunter's Point Facilities & SE Sewer Mods.	46 (0)	235 (0)	370 (0)	1 (98)	1 (100)	1 (99)	43 (0)	173 (0)	188 (0)	25 (34)	102 (67)	857 (49)	45 (0)	291 (0)	71 (0)
210	2. Griffith P.S. (120 MGD) and Force Mains	31 (33)	196 (17)	185 (50)	1	1	1	43	173	188	26 (32)	117 (62)	983 (41)	45	291	71
210	3. Yosemite/Fitch Outfalls	1 (98)	1.6 (99)	4.4 (99)	1	1	1	43	173	188	26 (32)	137 (56)	1152 (31)	45	291	71
210	4. Sunnydale Facilities	3.6 (92)	8.6 (97)	9.4 (95)	1	1	1	1 (98)	1.8 (99)	3.2 (98)	26 (32)	152 (51)	1204 (28)	45	291	71
	Phase II															
210	5. Griffith Reservoir and Outfall	1 (98)	2.5 (99)	5.8 (98)	1	1	1	1	1.8	3.2	26 (32)	166 (46)	1254 (25)	45	291	71
320	6. Islais Creek Facilities	1	2.5	5.8	1	1	1	1	1.8	3.2	9.8 (74)	37 (88)	359 (79)	45	291	71
320	7. Mariposa Facilities	1	2.5	5.8	1	1	1	1	1.8	3.2	10 (74)	39 (87)	369 (78)	9.2 (80)	35 (88)	13 (82)

Note: Numbers in parentheses denote, in percent, decreases in the respective overflow parameters.

REVISED 1/5/84

Annex III

Annex III

GEOTECHNICAL CONSULTANTS, INC.

San Francisco • Santa Ana • Ventura, California • Eugene, Oregon

GEOTECHNICAL INVESTIGATION

SUNNYDALE PUMP STATION/RESERVOIR FACILITIES

for

SAN FRANCISCO CLEAN WATER PROGRAM

JULY, 1985

111 New Montgomery St., Suite 600 • San Francisco, CA 94105 • Phone (415) 777-4870

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INTRODUCTION

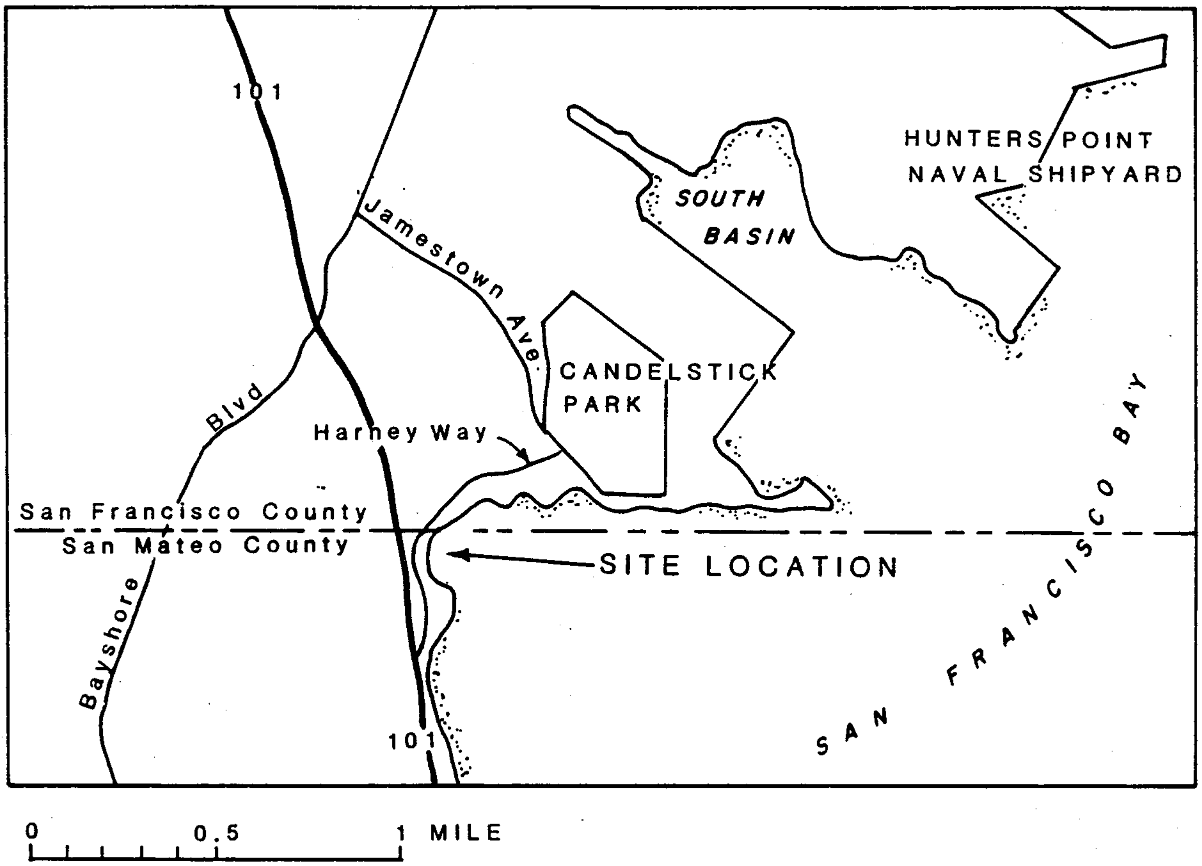
This report presents the findings, conclusions, and recommendations of a geotechnical investigation to evaluate the feasibility of locating the proposed Sunnydale Pump Station and Reservoir Facilities in the Candlestick Cove section of San Francisco Bay. As shown on Figure 1 - Location Map, the proposed facilities will occupy portions of both San Francisco and San Mateo Counties.

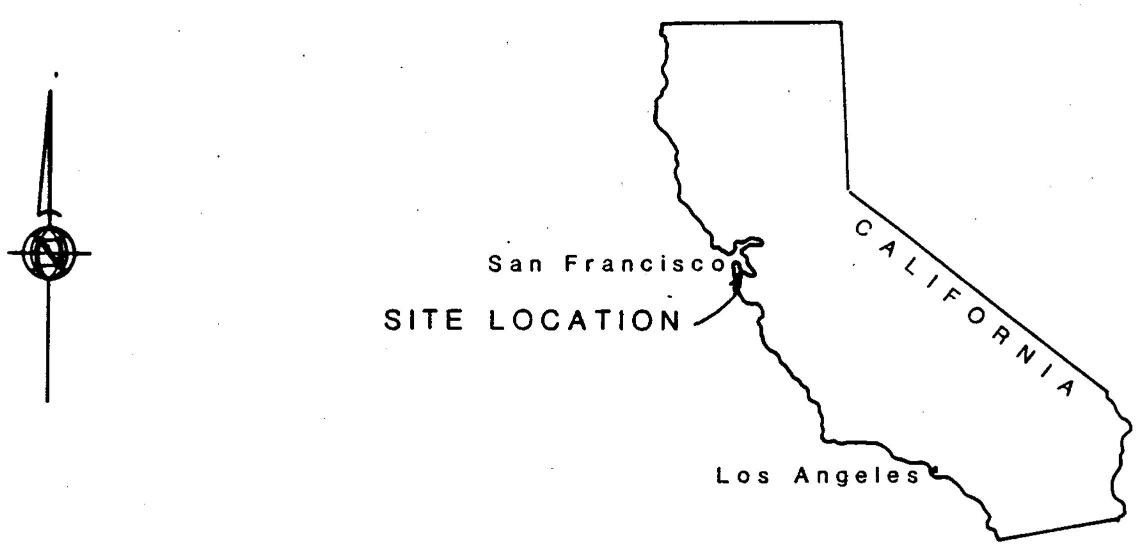
ALTERNATIVES

As described in Element 7 of the Bayside Facilities Plan, Expanded Geotechnical Investigation (Caldwell-Gonzalez-Kennedy-Tudor, 1982), the Sunnydale Pump Station and Reservoir Facilities previously proposed included an approximately 480-foot long by 140-foot wide concrete structure with an invert elevation that ranged from -26 to -31 feet, San Francisco City Datum (SFCD), a series of three box culverts running southward along Tunnel Avenue from the pump station and reservoir site to the existing Sunnydale Interceptor Sewer, a 60- to 66-inch diameter pipe that extends generally northeastward along Alana and Harney ways from the Sunnydale Interceptor Sewer to the Candlestick Tunnel, and a 36-inch diameter pipe that extends from an existing sewer on Harney Way to the proposed 60- to 66-inch pipe.

At present the city is evaluating the above structure plus three alternative designs for the proposed facilities. These alternatives, described the Clean Water Program as Alternatives 2-2B, 2-3A, and 2-6 are described below. Major structures for these alternatives are also shown on Plate 1 - Site Plan, Sunnydale Facilities.

FIGURE 1
LOCATION MAP





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Alternative 2-2B. This alternative comprises a 320-foot long by 150-foot wide, by 21-foot deep storage basin/pump station facility to be located on Sunset Scavenger Company Property, a 40-foot long, 10-foot by 10-foot box structure and a 70-foot long 8-foot by 6-1/2-foot double box structure connecting the reservoir to a control structure and a junction structure, respectively, on the existing Sunnydale Interceptor Sewer, a 1,550-foot long, 60- to 66-inch diameter sewer pipeline, and a 1,880-foot long 48-inch diameter force main. The 60- to 66-inch diameter pipeline and the 48-inch diameter force main will run northeastward along Alana Way and Harney Way to the Candlestick Tunnel, with invert elevations ranging from -3.7 feet to -15 feet. The geotechnical conditions along this alignment were described in detail in Element 7 of the Bayside Facilities Plan, Expanded Geotechnical Investigation.

Alternative 2-3A. This alternative will include a 1,350-foot long by 25-foot wide and 30-foot deep storage reservoir that will run northeastward from the existing Sunnydale Interceptor Outfall along the margins of Candlestick Cove to a pump station located about 250 feet southeast of the Candlestick Tunnel, 200 feet of 66-inch diameter pipeline, 430 feet of 60-inch diameter pipeline, 100 feet of 48-inch diameter force main and 40 feet of 36-inch diameter pipeline. The pipelines and force main will connect the pump station to existing sewer lines and to Candlestick Tunnel. The invert elevation for the reservoir will range from -33 feet at the existing outfall to -36 feet at the pump station, while the invert for the pump station will be -40 feet. Invert elevations for the pipelines will range from -13.3 feet to -15 feet at Candlestick Tunnel.

Alternative 2-6. This alternative consists of a 320-foot long by 150-foot wide by 21-foot deep pump station/storage reservoir facility to be located on Candlestick Point State Recreation Area land (undeveloped) just south of the intersection of Executive Park Boulevard and Harney Way, a 1,450-foot long 108-inch diameter pipeline extending northeastward from the existing Sunnydale Interceptor Outfall along the margin of Candlestick Cove to the proposed reservoir, a 200-foot long 66-inch diameter pipeline, a 430-foot long 60-inch diameter pipeline, a 200-foot long 48-inch diameter force main and a 40-foot long 36-inch diameter pipeline. The location and inverts of the 36-, 48-, 60-, and 66-inch diameter pipelines are similar to the location and inverts of the pipelines in Alternative 2-3A. The invert of the 108-inch diameter pipeline falls in elevation from -12 feet at the existing outfall to -20.5 feet at the reservoir/pump station facility. The invert of the proposed reservoir/pump station will be elevation -31 feet.

WORK PERFORMED

Work performed for this investigation has included:

1. A review of published and unpublished data and geotechnical literature for the project site and surrounding area.

2. Geologic reconnaissance of the area.

3. Completion of four exploratory drill holes to depths ranging from 32 to 98 feet below the ground surface. Drill hole locations are shown on Plate 2 - Drill Hole Location Map. Samples of the materials encountered were taken for identification and laboratory testing purposes. The logs of the drill holes are presented in Appendix A - Supporting Geotechnical Data.

4. Laboratory and field testing of the samples obtained to define the physical and engineering properties of the earth materials, including standard penetration tests and moisture and density determinations.

5. Geologic and geotechnical engineering analysis of the data obtained from the exploratory drilling program and the literature review to define the subsurface conditions at the site and to determine general foundation and structural design requirements for the proposed structure.

6. Preparation of a report presenting all findings, conclusions, and recommendations together with logs of the four exploratory borings.

FINDINGS

SITE CONDITIONS

A number of potential sites for the proposed facilities lie along the margin of Candlestick Cove in San Francisco Bay. Much of the land immediately onshore of these sites was reclaimed from the bay during the first half of the 20th Century (Dow, 1973). Development in the surrounding area is limited to roadways, including Highway 101, an office park immediately north of the proposed facilities, and Candlestick Park, approximately one quarter mile to the northeast.

GEOLOGY

The San Francisco Bay Area lies within California's Coast Ranges geomorphic province. Most major physiographic features in this structurally complex region trend in a northwesterly direction and reflect the underlying geologic structure. San Francisco Bay and the alluvial and estuarine deposits in the Candlestick Cove and Visitacion Valley area occupy a structurally controlled basin within the Coast Ranges province. Late Pleistocene and Holocene age sediments (less than 1.0 million years old) were deposited in this basin as it subsided (Atwater, Hedel, and Helley, 1977).

In the project, area bedrock of the Franciscan Formation is overlain by surficial deposits of colluvium/alluvium, bay side sand, younger bay mud and a thin layer of artificial fill. The areal distribution and stratigraphic thickness of these sediments are illustrated on Plate 3 - Bedrock Contours and Plates 4.1 and 4.2 - Geotechnical Profiles.

A stratigraphic column of the rock and soil types observed during exploration appears below in order from youngest to oldest with their ages listed in years before present (ybp):

Historic	Artificial Fill (0 to 200 ybp)
Holocene to Pleistocene	Younger Bay Mud (0 to 9,000 ybp)
	Bay Side Sand (0 to 40,000 ybp)
	Colluvium (0 to 100,000 ybp)
Cretaceous to Jurassic	Franciscan Formation (65,000,000 to 165,000,000 ybp)
	Sandstone
	Shale

The geologic structure in this area, particularly the orientation of structural discontinuities in the bedrock is not well known, because outcrops are scarce. However, based on the subsurface exploration program it would appear that the bedrock encountered during excavation will consist primarily of sandstone and shale.

A discussion of the stratigraphy and engineering properties of each of the materials encountered during the exploration program is presented below.

EARTH MATERIALS

The earth materials anticipated during construction of the pump station consist of artificial fill that was placed in the onshore and near shore areas during the last 150 years, the sediments that overlie bedrock throughout the project area, and sandstone and shale of the Franciscan Formation. A discussion of the areal distribution, lithology, stratigraphy, and engineering properties of each of the earth materials is presented below. The relative thickness of these materials in Candlestick Cove is illustrated on Plates 4.1 and 4.2.

Artificial Fill (af). The composition of the artificial fill that overlies the younger bay mud and bayside sand is a mixture of imported fine-grained quartz sand (SP), gravel to cobble-size chert and sandstone clasts (GP) and dredged shell fragments. These materials are primarily orange-brown to dark gray, loose to medium dense and poorly or gap graded. The artificial fill ranged in thickness from only 4 feet in Drill Hole 4 to 11 feet in Drill Hole 1. The fill encountered in Drill Holes 2 and 4 was primarily a fine grained Sandy Gravel (GP) with shell fragments and it appears to consist, at least in part, of material that was washed out of two separate storm drain outfalls.

Younger Bay Mud (Qyb). Previous investigators have divided the Holocene Age deposits of San Francisco Bay into a variety of stratigraphic members. For the purposes of this study, all of these members are combined into a single unit called younger bay mud, similar to Lawson's "Bay Mud" (1914). Deposition of these sediments extends from approximately 9,000 years before present (Atwater, et al., 1977).

The younger bay mud in Candlestick Cove is typically a blue-gray to black, very soft to soft and low to medium plasticity silty clay (CL/CH) with shell and organic rich layers throughout the section. The greatest concentration of shells encountered during this investigation occurred in Drill Hole 3 between Elevations -18 and -21.5 feet, where naturally occurring shell deposits comprised 60 to 70 percent of the section.

The shear strength of the younger bay mud encountered during drilling generally ranged from 200 to 400 pounds per square foot. In addition, consolidation tests conducted during previous investigations indicate that locally the younger bay mud may be underconsolidated.

The thickness of the younger bay mud encountered during drilling varied from 16 feet in Drill Hole 2 to 43 feet in Drill Hole 1. The thickness of the mud throughout the study area is illustrated on Plate 5 - Younger Bay Mud Isopach Map.

Bay Side Sand (Qbs). Deposition of the bay side sand is thought to have taken place during the Late Pleistocene and Holocene epochs, approximately 40,000 years ago through the present (Atwater, et al., 1977). These deposits are comprised of windblown and alluvial sands that were primarily deposited during a low sea level stand associated with the Wisconsin glaciation.

The bay side sand deposits in Candlestick Cove are typically reddish-brown to greenish-gray, fine grained, poorly graded, medium dense to very dense, subgrounded, quartz sand (SP) with occasional layers or lenses of gravelly sand (SP) and clayey sand (SC). Induration is generally slight and is attributable to the presence of silt and clay. Blow counts are generally greater than 50 blows per foot of penetration.

While the bay side sand was more than 69 feet thick beneath the northern section of the study area, it was absent in Drill Hole 2 and was only 13 feet thick in Drill Hole 1 in the southern section of the study area. The elevation of the upper surface of the bay side sand/colluvium section is illustrated on Plate 6 - Structural Contours of the Top of Bay Side Sand and/or Colluvium.

Colluvium/Alluvium (Qcol). For the purposes of this report colluvium/alluvium refers to a group of undifferentiated deposits that may include slope, ravine and stream wash debris, residual soils, and in some cases extremely weathered bedrock. In Candlestick Cove these materials are present as paleosols buried beneath the younger bay mud and bay side sand. The age of these sediments may range from Mid Pleistocene to Present.

The colluvial/alluvial deposits encountered during this investigation primarily consisted of orange-brown, fine to coarse grained, poorly graded, very dense, clayey sand (SC) and stiff to very stiff sandy clay (CL) with local layers of dark gray, poorly graded, very dense sandy gravel (GP). The clayey and sandy deposits typically contain subangular, coarse sand to fine gravel size sandstone, shale and chert rock fragments.

Colluvium/alluvium was encountered in Drill Holes, 1, 2, and 4. It ranged in thickness from 4 feet in Drill Hole 2 to at least 18 feet in Drill Hole 4. The contact between the colluvium/alluvium and the underlying bedrock occurred at elevations -70 and -34 feet in Drill Holes 1 and 2, respectively. The contact was not encountered in Drill Hole 4.

Franciscan Formation: Sandstone and Shale (KJss/KJsh). Sandstone and shale of the Franciscan Formation was encountered in Drill Holes 1 and 2. These materials were typically orange-brown, moderately to highly weathered, low to moderately hard and weak to moderately strong.

FAULTS AND SEISMICITY

As part of the Coast Ranges geologic province, the San Francisco Bay Area lies in a seismically active region. Faults in the Bay Area are shown on Plate 7 - Fault and Seismicity Map. The proximity of the site with respect to active and potentially active faults is presented on Table 1 - Active Faults. The data

TABLE 1

ACTIVE FAULTS

Fault	Distance to Project Site (miles)	Fault Length (miles)	Maximum Richter Magnitude (assigned)	Maximum Richter Magnitude (recorded)
San Andreas	6	745	8.3	8.3
Hayward	13	45	7.7	6.7
Calaveras	24	71	7.7	6.7
Seal Cove-San Gregorio	14	84	7.5	6.1
Healdsburg-Rodgers Creek	26	45	7.0	5.7

on maximum Richter Magnitude assigned and recorded are based on work by Kiremidjian and Shah (1975) and Borcherdt (1975). Most of these faults trend northwesterly and display a similar sense of right lateral, primarily horizontal movement. The Sunnydale Pump Station and Reservoir Facility will be located approximately one-half mile north of the City College fault zone. This fault does not display any evidence of recent movement or activity and is thus not considered active. Major active faults in the San Francisco Bay Area include the San Andreas and Hayward-Calaveras fault zones, both of which have produced measurable historic movement.

CONCLUSIONS AND RECOMMENDATIONS

1.0 FEASIBILITY

Based on a review of the geotechnical data pertinent to the area, it is our opinion that it is technically feasible to construct the proposed facility in the Candlestick Cove section of San Francisco Bay provided the conclusions and recommendations presented in this report are considered during project design. The major geotechnical considerations are support for temporary excavations, differential settlement between areas underlain by younger bay mud and bay side sand or bedrock, and hydrostatic uplift on buried structures. The seismicity of the San Francisco Bay Area will also be an important consideration in design of the structures.

2.0 SEISMIC HAZARDS

An evaluation of the seismic hazards for the proposed facility suggests that the potential for damage to the structure during an earthquake is small.

2.1 **Liquefaction Potential.** The storage reservoir/pump station facilities for the three new alternatives appear to be founded on either bedrock, bay side sand, or younger bay mud. The cohesive character of the younger bay mud and the relatively high density of the bay side sand indicate that these materials have a very low potential for liquefaction. However, if a loose, clean sand is encountered in the fill adjacent to the reservoirs in Alternatives 2-2B and 2-6 or beneath any of the pipelines, then significant ground movement and uplift pressures produced by liquefaction could affect these structures. Therefore, if an onshore site is selected the liquefaction problem should be evaluated in detail before final design of the project.

2.2 **Fault Rupture.** There is no indication that the site is underlain by an active or potentially active fault or that any such fault trends toward the site. Therefore ground rupture due to fault movement is considered unlikely.

2.3 **Soil Structure Interaction.** The location of the structure within the bay side sand and relatively near bedrock will subject the structure to high accelerations and an increase in seismic earth pressures during earthquake shaking, but will probably not result in large deformations. However, since the younger bay mud and bay side sand do not have the same acceleration period, burial of the structure across a contact between the two will produce racking and its related deformations. Therefore, if the structure is to be located within both the younger bay mud and the bay side sand, then the soil structure interaction should be investigated in detail prior to final design of the structures.

2.4 **Lateral Spreading.** Lateral spreading of the artificial fill may occur as a result of the occurrence of the design earthquake. Ground movement of this type was the cause of nearly all major pipeline breaks during the 1906 San Francisco earthquake (Youd and Hoose, 1978), and provisions should be made to allow for repair of damaged pipelines and box culverts if similar events should occur in the future.

3.0 GROUND WATER

The location of the structures along the margin of San Francisco Bay will result in ground water levels that are within a few feet of the ground surface during high tide. Therefore, the structure should be designed to resist the hydrostatic uplift and lateral forces imposed by ground water at the finished ground surface. The high ground water levels will necessitate dewatering and a positive ground water cutoff during construction. The dewatering system should be designed to provide a dry working area and to prevent boiling or heave of the excavation base.

4.0 PUMP STATION AND RESERVOIR DESIGN CONSIDERATIONS

4.1 **General.** The pump stations and reservoirs will be constructed in deep excavations. The excavation for Alternative 2-2B will probably be primarily through bedrock, with the exception of a thin layer of artificial fill blanketing the site. Unfortunately, the absence of any subsurface information at this site precludes a complete analysis of this structure. In contrast, based on the information illustrated on Plates 4.1 and 4.2, the excavations for Alternatives 2-3A and 2-6 will be through artificial fill and into younger bay mud and bay side sand. Please note that while the invert for the pump station/reservoir facility for Alternative 2-6 is not depicted on these profiles, it is believed to overlie a section similar to those depicted in profiles B-B' and C-C' and while younger bay mud may be encountered, the invert will probably be founded in bay side sand. Ground water levels are anticipated to be within a few feet of the ground surface at all three sites.

4.2 **Settlement and Foundation Design.** When the structures overlie younger bay mud they may be subjected to several inches of continuing areal settlement due to the consolidation of the younger bay mud under the weight of the artificial fill and while the weight of the structures will be less than the weight of the excavated soil the areal settlement will create downdrag loads on the structure.

If the structures overlie bedrock or dense bay side sand settlement is expected to be negligible. When the structures overlie both younger bay mud and bay side sand or bedrock, differential settlements may occur. Therefore, to provide uniform support for the structure and to prevent excessive differential settlement between different sections of the facilities it is recommended that where they overlie the younger bay mud the structures should be supported on piles and where they overlie the bay side sand the structures should be founded on a mat resting on the bay side sand. In addition, where there are only a few feet of bay mud below the invert of the proposed structure as appears to be the case with the reservoir in Alternative 2-6 and part of the reservoir in Alternative 2-3A, we would recommend overexcavation of the bay mud and replacing it with engineered fill resting on the bay side sand.

4.3 **Piles.** Piles should extend to bedrock or at least 20 feet into bay side sand, whichever is shallower.

High driving resistance will be experienced in the bay side sand, and it is recommended that prestressed concrete piles be predrilled to five feet above design tip elevation to avoid damage during driving. Predrilling should not be allowed for the final five feet of penetration into the bay side sand.

4.4 **Structural Mat.** Where the structure directly overlies bay side sand or colluvium it may be founded on a structural mat. The mat can be poured directly on the undisturbed bay sand or colluvium.

4.5 **Uplift Resistance.** The pump station/reservoir facilities should be designed to resist hydrostatic uplift due to the high ground water levels. This can be accomplished either by incorporating an adequate mass of concrete within the structure itself or by the use of tension piles and/or rock anchors. If needed, the weight of soil above slab collars may be used to supplement the uplift resistance provided by the weight of the structure.

5.0 LATERAL PRESSURES

Permanent lateral pressures on the walls of the pump station/reservoir and other facilities will include earth pressures from the adjacent structural backfill and hydrostatic pressures below the ground water level. Since the walls of the facilities will be rigid and restrained, at-rest earth pressures will develop.

The at-rest pressure exerted by structural backfill materials may be assumed equal to the pressure exerted by a fluid weighing 60 pcf above the ground water level. Below the ground water level, the at-rest pressure exerted by the structural backfill and ground water may be assumed equal to the pressure exerted by a fluid weighing 90 pcf.

Lateral pressures due to surcharges at the ground surface should be included in the design.

6.0 PIPELINE AND BOX CULVERT DESIGN CONSIDERATIONS

6.1 **General.** The pipelines and box culverts discussed in this report will generally be founded in bedrock or in the artificial fill overlying bedrock and the yonger bay mud. These alignments were not investigated during subsurface exploration for this report and they will require additional definition prior to final design of the facilities.

6.2 **Foundation Design.** It is noted that pipe sections and adjoining structures supported on firm soil, bedrock, or pile foundations will not experience significant settlement. The continuing areal settlement of the younger bay mud will therefore result in differential settlement if portions of the pipe are founded above the younger bay mud. To avoid the differential settlement, it is recommended that pipes which are underlain by younger bay mud be supported on piles which extend into the dense bay side sands or bedrock.

6.3 **Uplift Resistance.** The proposed pipelines and box culverts will be subject to uplift forces due to the high ground water levels. These forces may be resisted by incorporating an adequate mass in the structure itself, by utilizing the weight of soil above slab collars, by tension cables anchored into the underlying bedrock, and by utilizing the resistance provided by pile foundations.

7.0 EARTHWORK

7.1 **Excavation Characteristics.** Excavation of the soil overlying bedrock will be possible with the use of conventional grading equipment. However, since the younger bay mud is soft and saturated it will be difficult to work with and will not support heavy construction equipment.

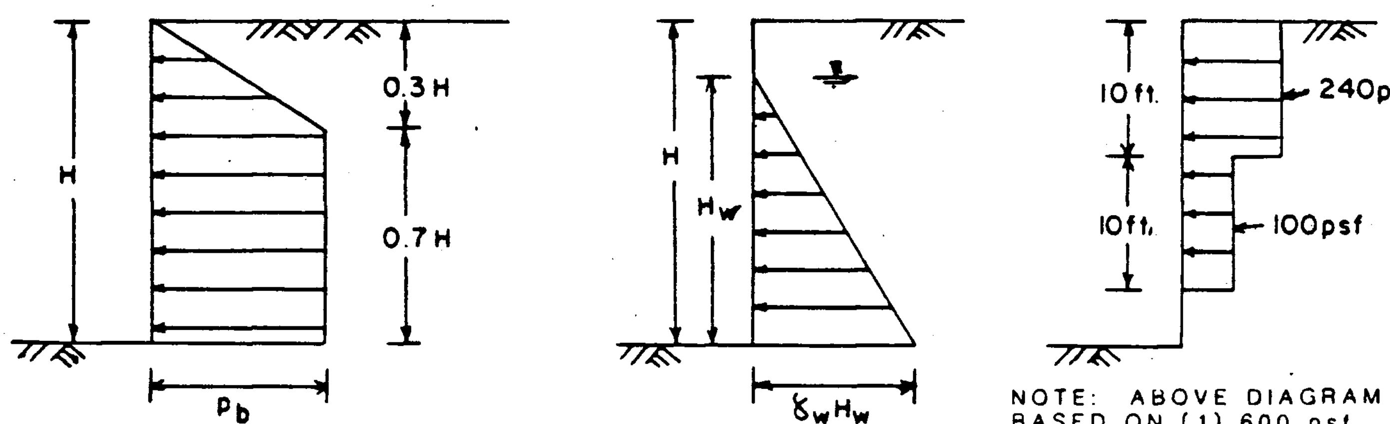
7.2 **Cut Slope Support.** Because space limitations and the proximity of San Francisco Bay will probably preclude the use of cut slopes shallower than 1-1/2 horizontal to 1 vertical, construction of most of the proposed structures will require deep braced and shored excavations into artificial fill, younger bay mud, bay side sand, and possibly colluvium and bedrock.

Temporary, internally braced and shored excavations in the subsurface soils will be subjected to the generalized earth pressures depicted on Figure 2 - Lateral Pressures for

FIGURE 2

LATERAL PRESSURES FOR TEMPORARY EXCAVATIONS

a) Earth Pressure b) Water Pressure c) Surcharge



NOTE: ABOVE DIAGRAM TO BE USED FOR STRATIFIED SOILS ONLY.

NOTE: ABOVE DIAGRAM IS BASED ON (1) 600 psf TRAFFIC SURCHARGE OVER A LIMITED AREA, AND (2) SANDY SOILS. SURCHARGE FOR STRATIFIED SOILS SHOULD BE EVALUATED FOR SPECIFIC CONDITIONS.

$$p_b = \gamma_a H - 2q_a$$

Where:

$$\gamma_a = \frac{1}{H}\left[\gamma_1 H_1 + \gamma_2 H_2 + \gamma_3 H_3\right]$$

$$q_a = \frac{1}{H}\left[\gamma_1 K_s H_1^2 \tan\phi_1 + H_2 n S_{u2} + \gamma_3 K_s H_3^2 \tan\phi_3\right]$$

In Fill:

γ_1 = 130 pcf above water, 67 pcf submerged
H_1 = thickness of fill
K_s = 1.0
ϕ_1 = 30 degrees

In Bay Mud:

γ_2 = 120 pcf above water; 57 pcf submerged
H_2 = thickness of Bay Mud
n = 1.0
S_{u2} = 400 psf

In Bay Side Sand:

γ_3 = 130 pcf above water; 67 pcf below water
H_3 = thickness of Bay Side Sand
K_s = 1.0
ϕ_3 = 32 degrees

Temporary Excavations. Lateral pressures due to surcharge loading should also be considered in design.

In addition, because of the sheared and broken nature of the bedrock in the surrounding area and the highly variable orientation of discontinuities, no definitive judgement can be made at this time with regard to the stability of cut slopes in the bedrock. Therefore, if excavation of bedrock is anticipated, as in the case of the reservoir in Alternative 2-2B, this problem will either require additional investigation before final design of the project or on-site inspection by a certified engineering geologist during construction.

7.3 **Excavation Base Stability.** Stability of the base of all excavations within soil will be dependent on ground water control, the proximity of the soft younger bay mud to the excavation base, and the dimensions of the excavation. When the excavation is in granular materials, it is recommended that the ground water level be maintained a minimum of two feet beneath the bottom of the excavation throughout construction in order to avoid base failure due to high seepage gradients.

Where younger bay mud occurs within or beneath the base of excavations, there may be a potential for bottom heave depending on the construction method, shoring system, excavation geometry, dewatering technique, and soil conditions. Ultimately, the contractor should evaluate the potential for bottom heave and utilize appropriate construction procedures to prevent excavation based instabilities.

7.4 **Engineered Fill.** When a structure is underlain by bedrock and native soil, the rock should be overexcavated to a depth of three feet below grade and compacted engineered fill should be placed to restore the excavated surface to foundation grade. This will prevent stress concentrations at the soil/rock interface, thus providing uniform support for the structure. On-site earth materials (with the exception of the younger bay mud) should be suitable for structural backfill provided that they are free of organics and other deleterious materials, that they have a liquid limit less than 35 percent and a plasticity index less than 12 percent, that not more than 25 percent of the material by weight is finer than the No. 200 sieve, and that the maximum particle size is 4 inches or less. The materials may be blended, screened, and/or crushed to meet these requirements. Imported materials which meet the above criteria are acceptable provided they are first approved by a qualified geotechnical engineer.

All engineered fill should be placed in layers not to exceed 8 inches in loose thickness and compacted to a minimum relative compaction of 90 percent as determined by standard test method ASTM D1557.

7.5 **Structural Backfill.** A minimum thickness of two feet of compacted structural backfill should be placed adjacent to the structures to provide uniform support and to restore the excavated surface to the proper grade. The structural backfill should conform to the requirements of Section 7.4 - Engineered Fill, except that compaction should be to a minimum of 90 percent relative compaction as determined by ASTM D1557. If the space between the side of the excavation and the structure is too small for adequate compaction of natural soils, pea gravel or clean sand may be used as structural backfill and may be vibrated into place.

8.0 CORROSION

Chemical analysis of samples of artificial fill, younger bay mud, and bay side sands taken from the borings during our previous investigation indicates that the Sunnydale Facilities will be placed in a mildly to severely corrosive environment. Damage to the structures and their foundation should be prevented by the use of protective coatings or other methods.

9.0 CLOSURE

This study is preliminary in nature and as such is not intended for use in the final design stage of the project. A thorough geotechnical investigation, including exploratory drilling and laboratory testing should be completed prior to design of the project.

The data and professional opinions presented in this report are within the limits prescribed by the client, and were developed in accordance with generally accepted professional geotechnical engineering and geologic practices. There is no other warranty, either express or implied.

Respectfully Submitted,
GEOTECHNICAL CONSULTANTS, INC.

Joseph F. Montagna
Civil Engineer #13408

Joseph M. Gonzalez
Engineering Geologist 562

REFERENCES

Atwater, B. F., C. W. Hedel, and E. J. Helley, 1977, Late Quaternary Depositional History, Holocene Sea-Level Changes, and Vertical Crustal Movement, Southern San Francisco Bay, California, U.S. Geological Survey Professional Paper 1014.

Bercherdt, R. D., 1975, Studies for Seismic Zonation of the San Francisco Bay Region, U.S. Geological Survey Professional Paper 941-A.

Caldwell-Gonzalez-Kennedy-Tudor, A Joint Venture, 1982, Expanded Geotechnical Investigation, Element 7: Sunnydale-Yosemite Transport/Storage Facility, prepared for the City and County of San Francisco.

Dow, G. R., 1973, Bay Fill in San Francisco: A History of Change; Master of Arts Thesis submitted to the University of California, San Francisco.

Kiremidjian, A. S., and H. C. Shah, 1975, Seismic Hazard Mapping for California; the John A. Blume Earthquake Engineering Center, Stanford University.

Lawson, A. C., 1914, San Francisco Folio, U. S. Geological Survey Atlas Folio 193.

Youd, T. L., and S. N. Hoose, 1978, Historic Ground Failures in Northern California Triggered by Earthquakes; U.S. Geological Survey Professional Paper 993.

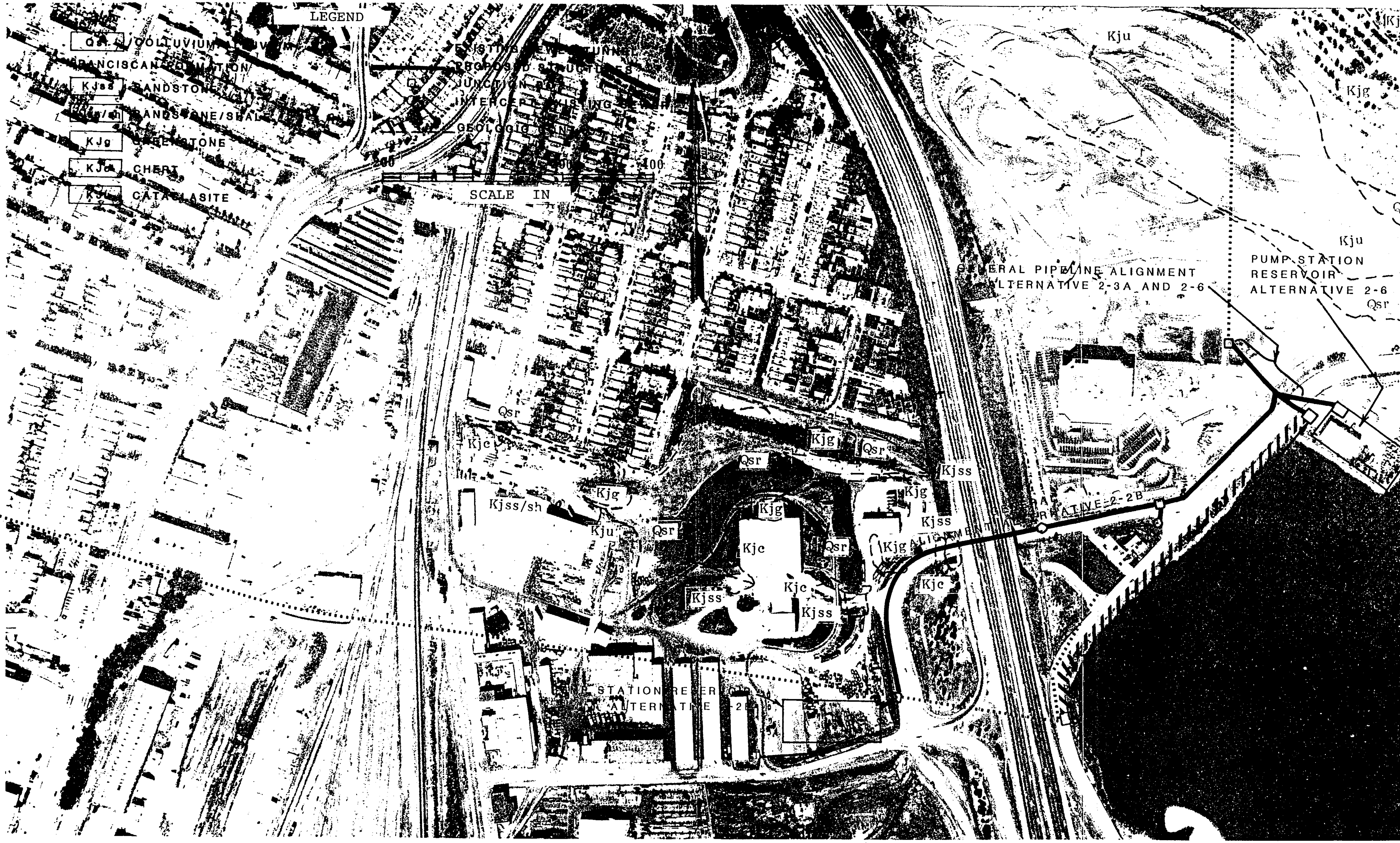
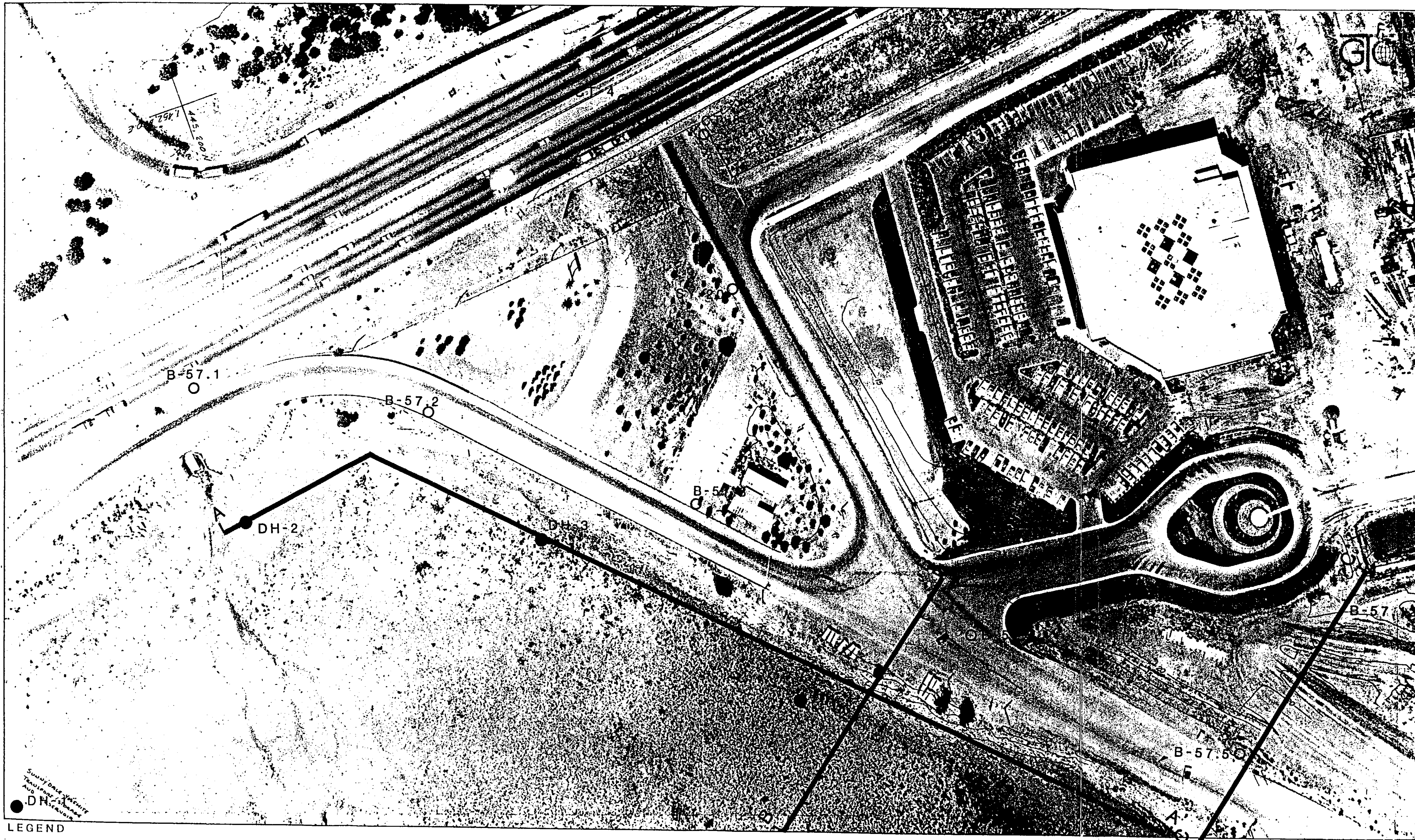


PLATE 1 SITE PLAN
SUNNYDALE FACILITIES
SF84006B JUNE, 1985



LEGEND

● DRILL HOLES COMPLETED FOR THIS INVESTIGATION

○ DRILL HOLES COMPLETED FOR PREVIOUS INVESTIGATIONS

SECTION LINES

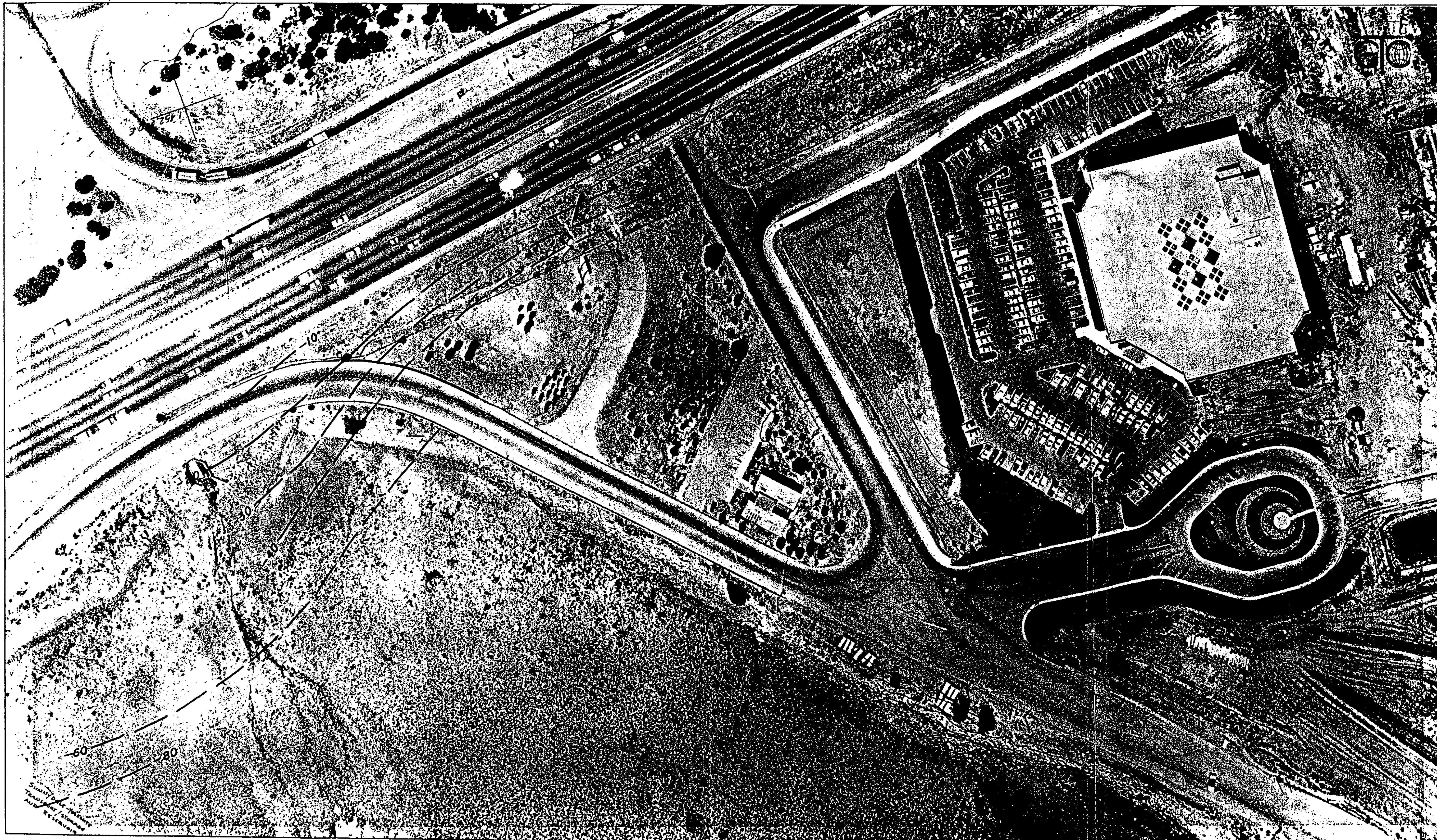
100 0 100 200

SCALE IN FEET

PLATE 2

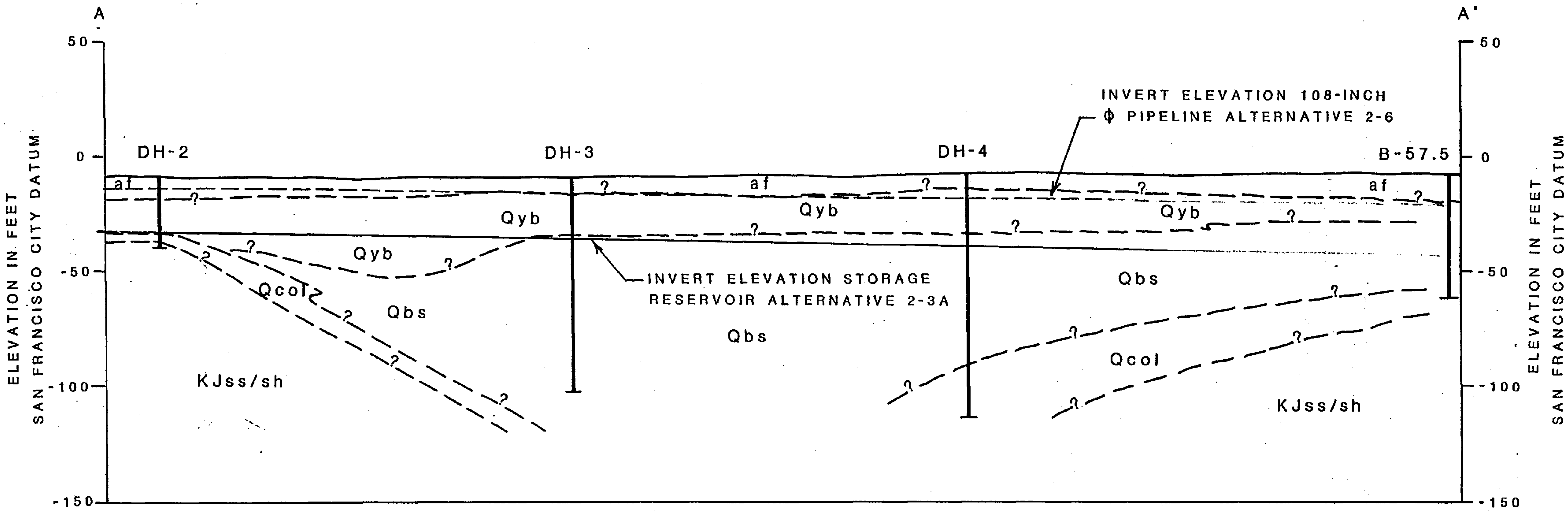
DRILL HOLE LOCATION MAP

SF84000B JUNE, 1985



BEDROCK CONTOURS
ELEVATION IN FEET (SFCD)

PLATE 3
BEDROCK CONTOURS
SI 64000B JUNE, 1985



LEGEND

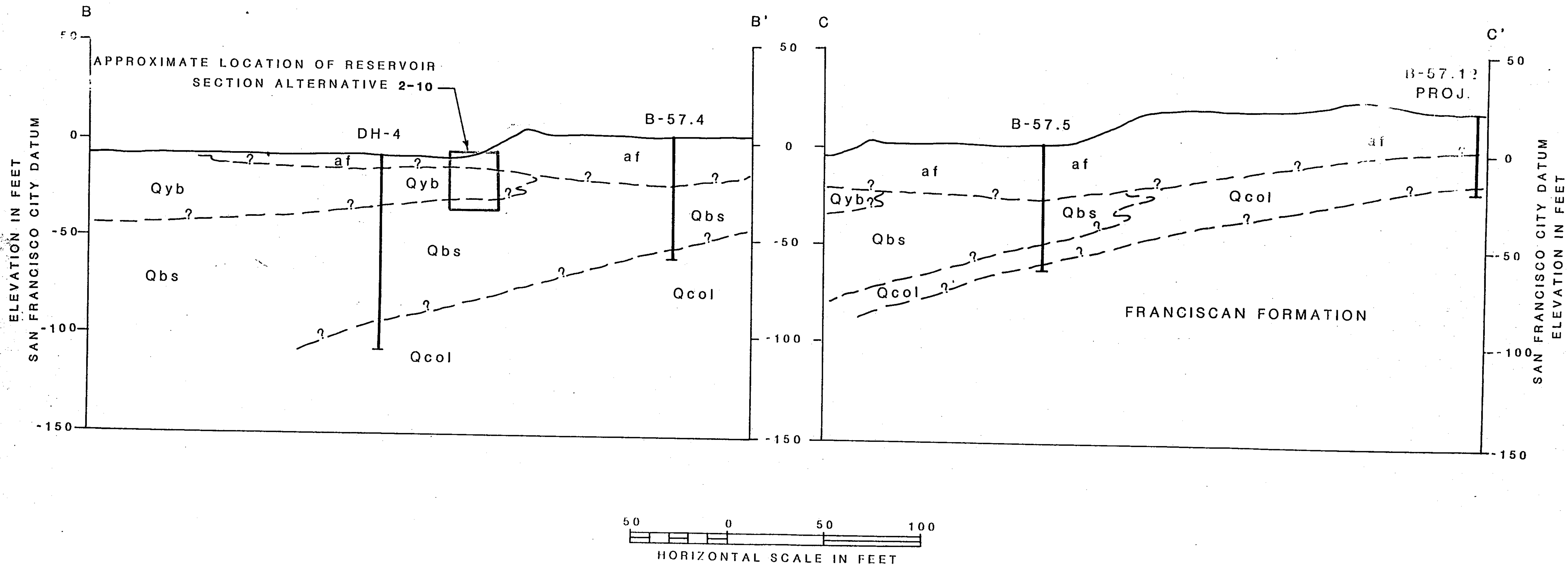
af	ARTIFICIAL FILL, LOCALLY OVERLAIN BY THIN DEPOSITS OF YOUNGER BAY MUD AND ALLUVIUM
Qyb	YOUNGER BAY MUD
Qbs	BAY SIDE SANDS
Qcol	COLLUVIUM/ALLUVIUM
KJss/sh	FRANCISCAN SANDSTONE AND SHALE

100 0 100 200

HORIZONTAL SCALE IN FEET

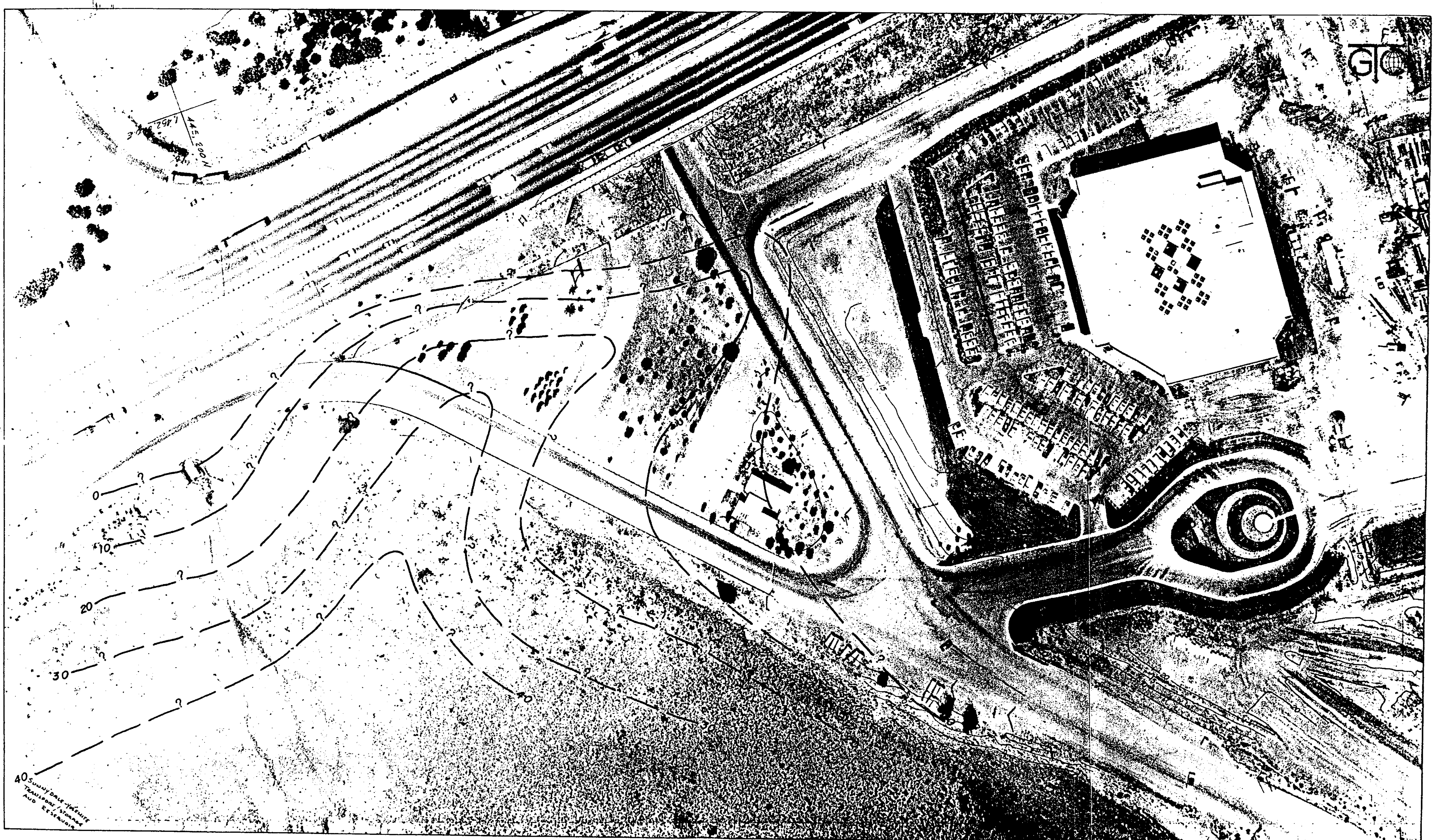
NOTE: SINCE B-57.5 WAS PROJECTED 150 FEET THE CONTACTS BETWEEN DH-4 AND B-57.5 ARE NOT WELL DEFINED.

PLATE 4.1
GEOTECHNICAL PROFILE
SF84000B JUNE, 1985



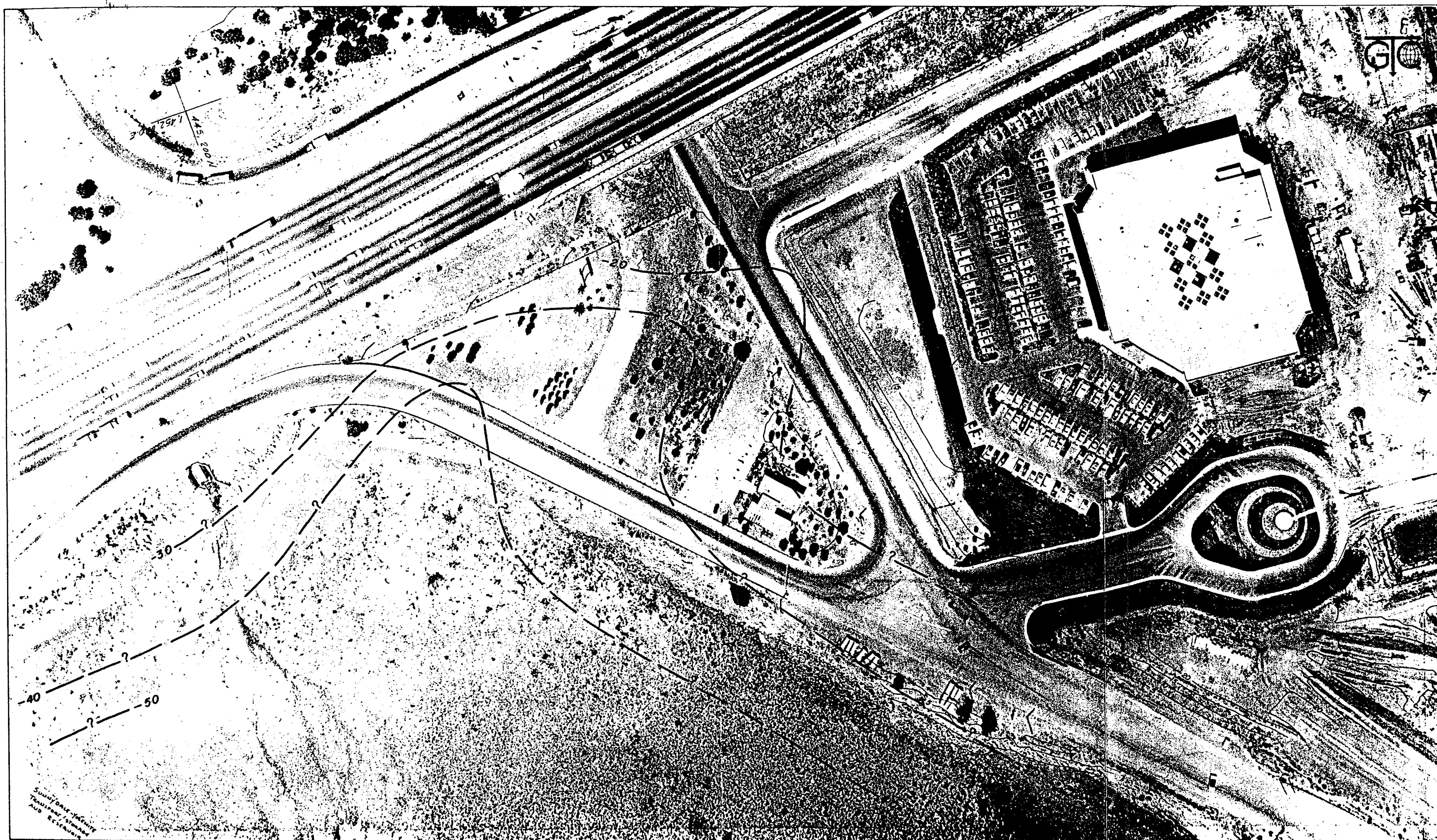
LEGEND ON PLATE 4.1

PLATE 4.2
GEOTECHNICAL PROFILES
SF84000B JUNE,1985



LINES OF EQUAL THICKNESS OF YOUNGER BAY MUD (FEET)

PLATE 5
YOUNGER BAY MUD ISOPACH MAP
SF84000B
JUNE, 1985



STRUCTURAL CONTOURS/BAY SIDE SAND AND/OR COLLUVIUM

PLATE 6
STRUCTURAL CONTOURS OF THE TOP OF THE BAY SIDE SAND AND/OR COLLUVIUM

SF84000B JUNE ,1985

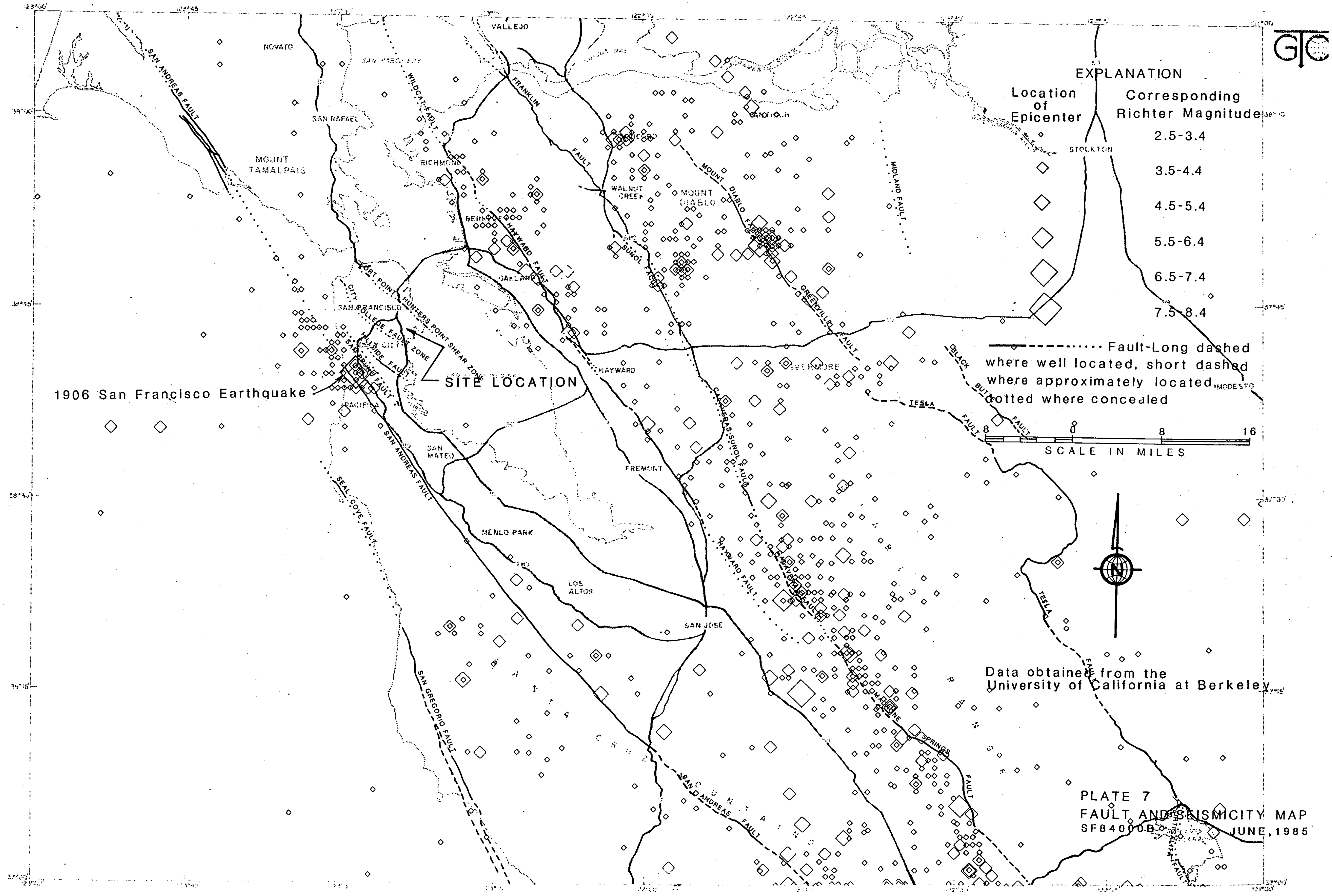


PLATE 7
FAULT AND SEISMICITY MAP
SF84000B JUNE, 1985

APPENDIX
SUPPORTING GEOTECHNICAL DATA

EXPLORATION

Exploration for this investigation consisted of drilling 4 rotary wash borings at the locations shown on Plate 1. The borings were drilled to depths ranging from 32 to 98 feet.

Logs of the drill holes presented as Plates A-1.1 through A-1.4 give descriptions of the earth materials encountered, show samples obtained and indicate field and laboratory tests performed. A legend to the logs is presented on Plate A-2. The stratification lines shown on the logs represent the approximate boundaries between soil types. Drill hole were located by paced measurements and the use of a range finder to determine the distance from known points. Elevations of drill holes were obtained using a hand level and range poles. The location and elevation of the drill holes should be considered accurate only to the degree implied by the method used.

SOIL SAMPLING METHODS

A variety of soil sampling methods was used during the exploration program.

The shelby, or thin-wall sampler was used to obtain samples of soft saturated clays. The sampler tube was pushed or driven not less than 24 inches or more than 27 inches into the soil. Undisturbed samples were taken at 5- to 10-foot intervals or where a change in soil conditions was encountered.

Standard penetration tests were performed within the soils to evaluate their in place densities. A 2-inch outside diameter, 1-3/8-inch inside diameter steel sampler was driven into the soil by repeatedly dropping a 140-pound safety hammer approximately 30 inches onto the drill rod to which the sampler was attached. The number of blows required to drive the sampler the last 12 inches of a total 18-inch interval is referred to as the standard penetration test blow count or N-value, and is recorded on the drill hole logs.

LABORATORY TESTING

Laboratory tests were performed on representative soil samples in order to define the engineering properties of the various earth materials. Testing procedures followed accepted practice where possible. Where ASTM Standards were used, the latest edition or revision for each test procedure was employed.

MOISTURE AND DENSITY DETERMINATIONS

Moisture content and dry density determinations were performed on all undisturbed samples to evaluate the natural water content and dry density of the various soils encountered. The results are presented on the drill hole logs.

TORVANE SHEAR STRENGTH

A torvane was used in the field to determine the shear strength of all undisturbed cohesive soil samples. These values were then rechecked by use of a torvane when the samples were opened in the soils laboratory. Since the tests performed in the field were conducted on a surface that may have been slightly disturbed during collection of the sample, the lab results are used whenever possible. The test results are presented on the drill hole logs.

JOB NO.: SF84000B
PROJECT: Sunnydale Pump Station
LOCATION: SP Property
DRILLING METHOD: Rotary Wash

LOGGED BY: NM
CHECKED BY: NM

DRILL HOLE NO.: 1
DRILLING DATE: 1/14/85
DATUM: City of San Francisco
REFERENCE EL.: -4 Feet

ELEVATION (FEET) / DEPTH	DRILLING RATE (MINUTES/FEET) AND CASING	SAMPLE	SAMPLE NO.	BLOW COUNT (BLOWS PER FOOT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	TORVANE (PSF)	ADDITIONAL TESTS
0						"Artificial Fill (af)" GRAVELLY SAND (SP), orange brown, medium to coarse grained, poorly graded, loose, with abundant shell fragments						
						2 feet: gravel to cobble size clasts of chert and sandstone						
-9	++++											
						"Artificial Fill (af)" SANDY GRAVEL (GP), orange brown, fine to coarse grained, poorly graded, loose, with cobble size clasts of chert and sandstone and abundant shell fragments						
			1	2								
10	++++											
						"Younger Bay Mud (Qyb)" SILTY CLAY (CL), with trace sand and some shell fragments, blue gray to black, very soft to soft, low to medium plasticity						
-19	++++											
		S	2				45	112			200	
						black, organic, SILTY CLAY (OH)						
20	++++					blue gray, SILTY CLAY (CH)						
		S	3				58	67			240	
-29	++++											
		S	4				61	67			400	
						28 feet: stiffer, abundant shells						
30	++++											
		S	5				51	84				
-39	++++											
						38 feet: very soft						
40	++++											
		S	6			fewer shells	57	71			260	
-49	++++											
						52 feet: organic SILTY CLAY (OH)						
50	++++											
						"Bay Side Sand (Qbs)" SAND (SP), greenish gray, fine grained, poorly graded, medium dense						
			7				60	62				
-59		S	7									

LEGEND TO LOGS ON PLATE A-2

JOB NO.: SF84000B
PROJECT: Sunnydale Pump Station
LOCATION: SP Property
DRILLING METHOD: Rotary Wash

LOGGED BY: NM
CHECKED BY: NM

DRILL HOLE NO.: 1
DRILLING DATE: 1/14/85
DATUM: City of San Francisco
REFERENCE EL.: -4 Feet

ELEVATION (FEET) DEPTH	DRILLING RATE (MINUTES/FEET) AND CASING	SAMPLE	SAMPLE NO.	BLOW COUNT (BLOWS PER FOOT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	TORVANE (PSF)	ADDITIONAL TESTS
-59			8	25		"Bay Side Sand (Qbs)" SAND (SP) greenish gray, fine grained, poorly graded, medium dense						
60						60 feet: color change to orange brown						
-69			9	48								
						"Colluvium (Qcol)" SANDY CLAY (CL) orange brown mottled yellow brown, very stiff, non-plastic						
70												
						"Colluvium (Qcol)" CLAYEY SAND (SC) orange brown, fine to coarse grained, poorly graded, very dense with coarse sand size sandstone and shale fragments						
-79												
80												
						"Franciscan Formation (KJf)" SHALE (KJsh) with interbedded SANDSTONE (KJss), orange brown, moderately to highly weathered, low to moderate hardness, weak to moderately strong						
-89												
90						primarily weathered sandstone and shale cuttings						
				(125/ 6")								
						Bottom of drill hole at a depth of 93 feet. Drill hole backfilled.						

SHEET 2 OF 2

LEGEND TO LOGS ON PLATE A-2

PLATE A-1.1

LOG OF DRILL HOLE

JOB NO.: SF84000B
PROJECT: Sunnydale Pump Station
LOCATION: Candlestick Cove
DRILLING METHOD: Rotary Wash

LOGGED BY: NM
CHECKED BY: NM

DRILL HOLE NO.: 2
DRILLING DATE: 3/2/85 - 3/4/85
DATUM: City of San Francisco
REFERENCE EL.: -9 Feet

ELEVATION (FEET)	DEPTH	SAMPLE NO.	BLOW COUNT (BLOWS PER FOOT)	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	TORVANE (PSF)	ADDITIONAL TESTS
	0			"Younger Bay Mud (Qyb)" SILTY CLAY (CL), with sand and fine gravel, blue gray to black, soft, low to medium plasticity						
-14				"Artificial Fill (af)"/outwash from storm drain outfall SANDY GRAVEL (GP), with shell fragments, dark gray, poorly graded, loose, subangular to angular, fine gravel and medium to coarse sand 5 feet: primarily gravel 6 to 8 feet: lens of SAND (SP) with abundant shell fragments, fine to medium grained, poorly graded, subrounded to well rounded 8 feet: SANDY GRAVEL (GP), as above with some clay						
	10	1	1							
-24				"Younger Bay Mud (Qyb)" SILTY CLAY (CL), with sand and shells, blue gray, very soft, low plasticity 12-1/2 feet: less sand, soft, increasing plasticity 16-1/2 feet: SILTY CLAY (CH) medium to high plasticity						
	20	2			53	84			360	
				24-1/2 feet: abundant shells, medium stiff						
-34				"Colluvium/Alluvium (Qcol)" SANDY GRAVEL (GP), with shell fragments and minor clay, dark gray to black, poorly graded fine gravel and medium to coarse sand, primarily comprised of sandstone and shale rock fragments, with some chert						
	30	3	93	"Franciscan Formation (KJf)" SANDSTONE (KJss), orange-brown, highly weathered, friable 31-1/2 feet: occasional cuttings of dark gray moderately weathered sandstone						
				Bottom of drill hole at a depth of 32 feet.						

LEGEND TO LOGS ON PLATE A-2

LOG OF DRILL HOLE

JOB NO.: SF84000B
PROJECT: Sunnydale Pump Station
LOCATION: Candlestick Cove
DRILLING METHOD: Rotary Wash

LOGGED BY: NM
CHECKED BY: NM

DRILL HOLE NO.: 3
DRILLING DATE: 3/7/85 and 3/8/85
DATUM: City of San Francisco
REFERENCE EL.: -9 Feet

ELEVATION (FEET) / DEPTH	DRILLING RATE (MINUTES/FEET) AND CASING	SAMPLE	SAMPLE NO.	BLOW COUNT (BLOWS PER FOOT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	TORVANE (PSF)	ADDITIONAL TESTS
0						"Younger Bay Mud (Qyb)" SILTY CLAY (CL), with shells and minor gravel, blue gray to black, soft, low plasticity						
						"Artificial Fill (af)" SANDY GRAVEL (GP), with shells, dark gray, poorly graded, loose fine gravel and coarse sand, sandstone rock fragments						
-14						4 feet: one foot thick lens of fine to medium grained SAND (SP), with shells; 5 feet: primarily chert rock fragments, some brick and glass						
10						"Younger Bay Mud (Qyb)" SILTY CLAY (CL), with shells, blue gray, soft, low plasticity, minor gravel						
-24						7-1/2 feet: abundant shells, no gravel; 9 feet: 60 to 70 percent shells with fine sand; 12-1/2 feet: some coarse sand and fine gravel, well rounded; 14 feet: 2 foot thick peat rich lens, green gray						
			1			17-1/2 feet: cobble size chert clasts in a clay matrix SILTY CLAY (CH), medium to high plasticity	60	69			400	
20												
-34						25 feet: lens of chert gravel						
						"Bay Side Sand (Qbs)" SAND (SP), orange-brown, fine grained, poorly graded, very dense, subrounded to well rounded quartz sand						
30			2	84								
-44												
			3	117		36 feet: easier drilling, 1-1/2 foot thick lens of GRAVELLY SAND (SP), medium dense to dense, gravel is fine grained						
40						harder drilling, water clear						
						43 feet: easier drilling, trace clay, water muddy; 44 feet: clean fine sand						
-54												
50						52 feet: water becomes muddy, sand fine to medium grained						
-64												

LEGEND TO LOGS ON PLATE A-2

LOG OF DRILL HOLE

JOB NO.: SF84000B	LOGGED BY: NM	DRILL HOLE NO.:	3
PROJECT: Sunnydale Pump Station	CHECKED BY: NM	DRILLING DATE:	3/7/85 and 3/8/85
LOCATION: Candlestick Cove		DATUM:	City of San Francisco
DRILLING METHOD: Rotary Wash		REFERENCE EL.:	-9 Feet

ELEVATION (FEET)	DEPTH	DRILLING RATE (MINUTES/FEET) AND CASING	SAMPLE	SAMPLE NO.	BLOW COUNT (BLOWS PER FOOT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	TORVANE (PSF)	ADDITIONAL TESTS
-64							"Bay Side Sand (Qbs)" SAND (SP), orange-brown, fine grained, poorly graded, dense to very dense, subrounded to well rounded quartz sand						
	60						57 feet: water very clear 58 feet: harder drilling						
-74													
	70												
-84							77 feet: 1/2 foot thick lens with medium grained sand, primarily chert rock fragments						
	80												
-94							86 feet: harder drilling						
	90												
-104													
							Bottom of drill hole at a depth of 95 feet.						

LEGEND TO LOGS ON PLATE A-2

LOG OF DRILL HOLE

JOB NO.: SF84000B
PROJECT: Sunnydale Pump Station
LOCATION: Candlestick Cove
DRILLING METHOD: Rotary Wash

LOGGED BY: NM
CHECKED BY: NM

DRILL HOLE NO.: 4
DRILLING DATE: 3/11/85 and 3/12/85
DATUM: City of San Francisco
REFERENCE EL.: -10 Feet

ELEVATION (FEET)	DEPTH	SAMPLE NO.	BLOW COUNT (BLOWS PER FOOT)	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	TORVANE (PSI)	ADDITIONAL TESTS
	0			"Artificial Fill (af)"/overwash from storm drain outfall GRAVELLY SAND (SP), orange-brown, poorly graded, loose, fine to medium grained sand and fine gravel						
-15				"Younger Bay Mud (Qyb)" SILTY CLAY (CL), dark gray to black, soft, slight to low plasticity 7 feet: color change to blue-gray, some sand and shells 8-1/2 feet: gravel and shells in a matrix of silty clay 9 feet: 1 foot thick lens of SANDY GRAVEL (GP)						
	10	1	6	"Younger Bay Mud (Qyb)" CLAYEY SAND (SC), with shells and fine gravel, blue gray, medium to coarse grined, poorly graded, loose 12 feet: more shells						
-25				"Younger Bay Mud (Qyb)" SILTY CLAY (CL), with shell fragments and some medium grained sand, blue gray, soft, slight to low plasticity						
	20	2		"Younger Bay Mud (Qyb)" CLAYEY SAND (SC) with shells and fine gravel, blue gray, fine to medium grained poorly graded loose to medium dense, clay less than 20 percent	97	28				
-35				"Bay Side Sand (Qbs)" SAND (SP), with minor shell fragments, blue-gray, fine grained, poorly graded, dense to very dense, quartz sand 26 feet: harder drilling 28 feet: color change to orange-brown, with minor medium grained sand						
	30	3	84	30 feet: 1/2 foot thick lens of GRAVELLY SAND (SP) 32-1/2 feet: easier drilling						
-45										
	40			3 inch lens of fine gravel						
		4	80/8"	"Bay Side Sand (Qbs)" GRAVELLY SAND (SP), orange-brown, gap-graded, very dense, fine quartz sand with fine chert gravel						
-55				47-1/2 feet: harder drilling 49-1/2 feet: 3 foot thick lens of CLAYEY SAND (SC) with gravel						
	50			"Bay Side Sand (Qyb)" SAND (SP), orange-brown, fine grained, poorly graded, very dense, quartz sand 54 feet: 1 foot thick lens of CLAYEY SAND (SC) with gravel						
-65										

LEGEND TO LOGS ON PLATE A-2

LOG OF DRILL HOLE

JOB NO.: SF84000B
PROJECT: Sunnydale Pump Station
LOCATION: Candlestick Cove
DRILLING METHOD: Rotary Wash

LOGGED BY: NM
CHECKED BY: NM

DRILL HOLE NO.: 4
DRILLING DATE: 3/11/85 and 3/12/85
DATUM: City of San Francisco
REFERENCE EL.: -10 Feet

ELEVATION (FEET)	DEPTH	DRILLING RATE (MINUTES/FEET) AND CASING	SAMPLE	SAMPLE NO.	BLOW COUNT (BLOWS PER FOOT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	TORVANE (PSI)	ADDITIONAL TESTS
-65							"Bay Side Sand (Qbs)" SAND (SP), with minor clay, orange-brown, fine grained, poorly graded, very dense						
	60						60 feet: orange-brown mottled tan to gray, with some coarse sand to fine gravel size chert and sandstone rock fragments, sandstone rock fragments exhibit some weathering						
-75							65-1/2 feet: only minor fine gravel						
	70						70-1/2 to 72-1/2 feet: easier drilling						
-85													
	80						80 feet: more coarse sand and fine gravel size rock fragments						
							"Colluvium/Alluvium (Qcol)" CLAYEY SAND (SC), reddish-orange, fine grained, poorly graded grading to a light tan CLAY (CL) at 81 feet, soft to medium stiff						
-95							82 feet: 1 foot thick lens of blue-gray SILTY CLAY (CL) with shell fragments 83 feet: SANDY CLAY (CL) with coarse sand and fine gravel size chert and sandstone rock fragments, orange-brown, stiff to very stiff						
	90						84 feet: some fine sand, minor weathered shale and sandstone 86 feet: CLAYEY SAND (SC), with chert rock fragments and cuttings, orange-brown, medium to coarse grained poorly graded 87-1/2 feet: rig starts to chatter						
-105							89-1/2 feet: SANDY CLAY (CL) as above 90-1/2 feet: fewer rock fragments 95-1/2 feet: sandstone rock fragments with some chert						
							Bottom of drill hole at a depth of 98 feet.						
	100												

LEGEND TO LOGS ON PLATE A-2

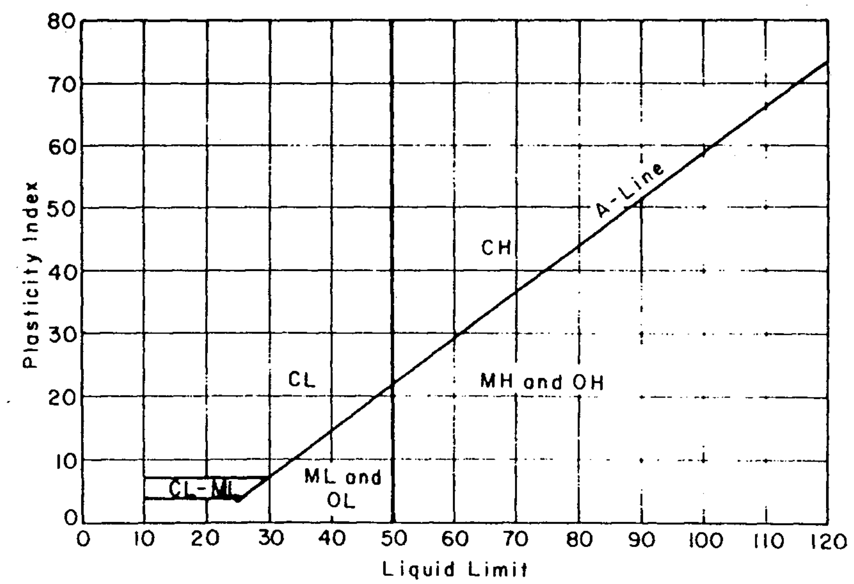
Plate
A-2.1

Definition of Terms and Symbols

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISION			GROUP SYMBOL	DESCRIPTION	GRAPHIC LOG
COARSE GRAINED SOILS OVER 50% BY WEIGHT COARSER THAN NO. 200 SIEVE SIZE	GRAVELLY SOILS OVER 50% OF COARSE FRACTION LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELLY SOILS LITTLE OR NO FINES	GW	WELL GRADED GRAVELS OR GRAVEL-SAND MIXTURES	
			GP	POORLY GRADED GRAVELS OR GRAVEL-SAND MIXTURES	
		GRAVELLY SOILS WITH FINES OVER 12% FINES	GM	SILTY GRAVELS OR POORLY GRADED GRAVEL-SAND-SILT MIXTURES	
			GC	CLAYEY GRAVELS OR POORLY GRADED GRAVEL-SAND-CLAY MIXTURES	
	SANDY SOILS OVER 50% OF COARSE FRACTION SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDY SOILS LITTLE OR NO FINES	SW	WELL GRADED SANDS OR GRAVELLY SANDS	
			SP	POORLY GRADED SANDS OR GRAVELLY SANDS	
		SANDY SOILS WITH FINES OVER 12% FINES	SM	SILTY SANDS OR POORLY GRADED SAND-SILT MIXTURES	
			SC	CLAYEY SANDS OR POORLY GRADED SAND-CLAY MIXTURES	
FINE GRAINED SOILS OVER 50% BY WEIGHT FINER THAN NO. 200 SIEVE SIZE	SILTY AND CLAYEY SOILS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY	
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, OR LEAN CLAYS	
			OL	ORGANIC CLAYS OR ORGANIC SILTY CLAYS OF LOW PLASTICITY	
	SILTY AND CLAYEY SOILS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, OR ELASTIC SILTS	
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, OR FAT CLAYS	
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, OR ORGANIC SILTS	
HIGHLY ORGANIC SOILS			Pt	PEAT OR OTHER HIGHLY ORGANIC SOIL	

PLASTICITY CHART - Used for classification of fine grained soils



SAMPLE - Sample types are indicated as follows:

Undisturbed

Disturbed

Unsuccessful Attempt

Standard Penetration

✳ = SAMPLER TYPES

M = Modified California
S = Shelby Tube (Pushed)
PT = Pitcher Barrel
P = Hydraulic Piston

Water Level

Water Inflow

BLOW COUNT - The number of blows required to drive the indicated sampler the last 12 inches of an 18 inch drive. The notation 100/9 indicates only 9 inches of penetration were achieved in 100 blows. Hammer driving weights and drop heights are shown as indicated below:

Symbol	Driving Weight (pounds)	Drop Height (inches)
7	140	30
(3)		
[6]		
④		
[5]		
⑥		

Heavy Caving

Light Caving

ADDITIONAL TESTS-

UC : Unconfined Compression
TD : Triaxial Compression, Drained
TU : Triaxial Compression, Undrained
TDy : Triaxial Compression, Dynamic
pH : Hydrogen Ion Concentration
PA : Paleontologic Analysis
GS : Grain Size Distribution
WP : Water Pressure
PMt : Pressuremeter
SE : Sand Equivalent
GJ : Goodman Jack
SP : Specific Gravity
CP : Compaction
C : Consolidation
DS : Direct Shear
PM : Permeability
EX : Expansion
RS : Resistivity
S : Swell
CL : Chloride
SU : Sulphate

PLATE A-2.1 LEGEND TO DRILL HOLE LOGS